The
Pianoforte Tuner's
Pocket Companion

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Complied from Lectures of

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For use of the pupils of

The Faust School

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ERRATA

On all pages between 7 and 94 inclusive, where the word "jack-rocker" occurs, substitute the word "whippen".

Where the word "tallow" is used substitute "graphite or mineral grease".

CONSTRUCTION OF THE PIANO-FORTE.

The construction of piano-fortes is an art that has not been fully recognized by the public. The smallest details require the most careful attention of the architect and artist.

The important parts of the piano are keys, action, strings, plate, pin-block sounding board and skeleton frame.

The keys of the piano did not come into use until the invention of the Virginal, an instrument somewhat resembling a harpsichord, but smaller and having an oblong shape like the square piano.

There was only one wire to each note. The compass was about three octaves. The tone was not sustained as in the piano of to-day but as soon as the quill or piece of leather on the end of the jack struck or plucked the string, the jack by its own weight returned to its position of rest. On this jack was also attached the damper that would prevent the strings vibrating as soon as the jack returned. This instrument was used in the sixteenth century, but is now wholly obsolete. The piano action of today has developed from a very simple or crude form of a jack fixed in the key with a small piece of crow-quill or a piece of leather projecting out from the jack that stood upright and was pushed upwards by the key till the quill or leather struck the string causing the string to vibrate which produced a harsh sound entirely deficient of any means of modification in respect to loudness or softness. The piano-forte being a stringed instrument, it is evident that the strings are the generators and the sounding board is the reflector or resonator.

The hammers are the means of setting the strings in vibration, and the sounding board of reflecting the vibrations, without which, the piano would be a voiceless machine. The earliest form of producing a tone from a string was used by the savages of southwestern Africa. When not using their bows in war or for game they would tighten the string nearly in the middle with a strap of leather, thus obtaining two dull sounds that were scarcely audible. While another tribe had advanced enough to use a hollow shell open at the top; and still another made use of the wooden sounding board in which case more than one string was used.

To make the vibrations of a string audible, the string must rest on a bridge, and the bridge must rest on the sounding board, which will throw out the vibrations.

The sounding board has developed from the strip of wood and hollow shell, to that used in the drum, the violin and the piano. It is probable that the earliest musical instrument of the world was a rattle, and as civilization progressed a whistle came into use, made out of a piece of bone, later a pipe with three finger holes was used. A whistle with five finger holes is used among the shepherds of Barbary in northern Africa.

It seems probable that the ancestor of the piano is the Dulcimer, an instrument having about fifty brass wires and resembling a flat box with sounding board and bridges. It was tuned by pegs at the side, and played on by striking the wires with two cork headed hammers. It was carried in the hand like a harp. It is one of the most ancient of instruments, and is supposed to be the same as the psaltery of the Hebrews. The clavichord contained from thirty-five to seventy strings. The invention of the piano-forte is accredited to Bartolomeo Cristofori, an Italian, born at Padua in 1653 and died at

Florence in 1731. He produced his instrument in 1711. Pianos built by Cristofori about 1714 had but four octaves and were only two unison. The strain on this piano was between seven and eight thousand pounds. Others that claim the honor of the invention of the piano-forte are a German organist by the name of Schroter, and Marius, a French harpsichord maker.

Erard, Backers, Broadwood, and Southwell are among the earliest inventors.

Babcock and Chickering are names that must be considered in its history. Therefore no one country can claim the invention of the piano-forte. The first piano built in America was at Philadelphia, by John Behrent in 1775. Ten years later George Ulschoefer began manufacturing in New York. Bent in 1797, and Crehore in 1800 began manufacturing in Milton, Mass. The tone produced by bells, gongs, triangles and forks has a high metallic twang, while that produced from wood is rich and full.

Wood is not as easily set in vibration as metal, but the tone has more resonance. It is evident then that the manufacturer does not trust to iron when considering tone, as this is a factor of strength used to resist the enormous strain caused by the tension of the strings, that in some pianos reaches twenty to thirty tons. The part of the piano that the manufacturer can claim as his exclusive invention is the scale. By the scale is meant the plan and proportion of the instrument, the length and diameter of the wire used for each note.

The point at which the wire is struck by the hammer. The height and shape of the sounding board bridge. The size and thickness of the board. The shape and number of bars on the board. This question of scale in the piano is the heart or soul of the piano and taxes the skill of the scale drawer and has made it necessary for a great deal of experimenting with many materials for strings, as the pitch of a string depends upon the rapidity of vibration. The rapidity depends upon the length, thickness, tension, stiffness and weight of the string. Brass, copper, gold, platinum, silver and steel have been tried for stringing. Steel has proven itself superior to all others for piano wire. In the bass where the strings are shorter than the pitch requires, the plain steel wire must be covered with copper or soft iron wire to load or weight it sufficiently to lower the pitch as may be required.

Piano manufacturers concede that the point at which the hammers strike the strings greatly affects the tone, although they do not all use the same striking point. The nearer the centre the hammer strikes the strings the fewer the partial tones. The nearer the end the hammer strikes the string the greater the number of partial tones, as the hammer is moved toward the centre of the string, the tone becomes hollow, and has the character of a simple tone, as the tuning fork or a pipe of an organ. If the hammer is moved towards the end of the strings the tone becomes more harsh and penetrating. This accounts for some pianos that are comparatively new having such a metallic sound when the hammers become the slightest worn. This metallic tone is caused by the presence of a number of dissonant partial tones, that are absent when the string is struck nearer its centre. In the most scientifically constructed pianos the striking point is one-eighth or one-ninth of the length of the string. This is even less in the extreme treble. The size, weight and shape of a hammer has as much to do with the tone of a piano as the strings and the sounding board. Hammer makers are constantly experimenting, thereby improving their hammers a great deal. Too large or soft a hammer will have the effect of damping the strings. If too light the tone will be correspondingly light. If too hard or poorly regulated it will destroy the tone.

The length of time that the hammer rests against the string in striking must be just long enough to set the string in vibration. This is controlled by the action and is just a fraction of a second. At one time hammers were made out of leather and buckskin. To-day they are made out of hair and wool. The outer layer being the softer of the two or more layers of felt. This felt is glued to the head with an enormous pressure, and when the glue has thoroughly dried the hammers are sawed in their required width. In upright and grand pianos they are wired to prevent the felt separating from the head.

The action of the piano is the mechanism which conveys the stroke of the finger to the hammer, that in turn strikes the strings. A repetition action had been patented as early as 1821 by Erard, at Paris. This action has been greatly improved and is a favorite among the American manufacturers of pianos. The key is the lever that is lowered by the finger, thus carrying with it in the upright the extension, jack-rocker, jack and hammer. If a piano is strung with heavy wire the hammers must be correspondingly heavy to set the strings in vibration. This produces a full rich tone. Therefore on account of the largeness of the hammers a greater key leverage must be employed to keep the touch light. Key leads are also used to lighten and equalize the touch. The action is so regulated that the finger does not lose control of the hammer until the key is almost down. If a tuning fork is set in vibration and held in the hand there will be no sound. It is the same with the strings of a piano, unless a sounding board is used to reflect the vibrations of the strings.

The sounding board of a piano consists of the following parts. Bridge, board and ribs. The bridge supports the strings and the bars or ribs support the board. If there are too many bars the tone will be dull, and if too few bars the tone will be light and thin, and the board is liable to sag: thus preventing the strings from resting firmly on the bridge. If the strings are loose on the bridge they cannot communicate their vibrations to it, which results in a thin tinkling tone. Some think that coarse grained wood is best for the bass, and fine grained for the treble, and others choose spruce that has grown on cool, high and stony soil as the grain is finer than that from warm and damp land. Again some choose the boards from the north side of a tree rather than those from the south side. This is impracticable and is not the custom as most makers of pianos do not know from which side of a tree their boards come.

Before the ribs are glued on they are beveled by plaining them, in order to crown the board. This upward curve resists the downward pressure of the strings.

A soft white grained piece of spruce will give more tone in the bass, and a hard pitch grain will give more tone in the treble. The thickness of a board in the treble is about three-eighths of an inch and in the bass about three-sixteenths. Bell tones are sometimes caused by a board being too thick or having an uneven rigidity. An expert board maker can usually remedy this evil by scraping the bars a little or by changing the position of the bars. Some upright pianos have a very large sounding board as the board will fill the whole space from the lower edge of the pin block down to the base blocks, also from side to side of the case. This style board, owing to its size is affected very much more by climatic changes than a board that does not cover the whole back of the piano, and owing to its elasticity will cause a false tone, that has lost much of the purity that is found in pianos with a smaller board. A bridge that extends a little beyond the end notes is more favorable to tone than one that stops at end notes. At the back of the upright and bottom of the grand piano is the skeleton frame. This frame sustains the pulling force of the strings. The plate alone is not sufficient. The plate and pin block are screwed and bolted to the frame. Upon this rests the security of the piano standing in tune. A slight movement of this frame would result in throwing the whole system out of order. The beams of the skeleton frame run nearly parallel with the strings, this prevents the piano from bowing or springing.

Alfeas Babcock is supposed to be the inventor of the full iron plate which he had patented about 1825. Before this the braces were detachable.

The construction of the upright piano-forte case.

The casters.

There has been three styles of casters used in the piano.

1st. A small wheel on a swivel.

2nd. A ball bearing disk that is fastened to the post of the swivel shaft.

The balls in this caster number five. They do not all fit tightly and therefore very often cause a rattling that cannot be remedied unless the castors are changed.

3rd. A ball bearing caster that consists of three balls placed at the top of the post or shaft of the swivel. These balls are so arranged that the weight of the piano prevents them from being loose, thus putting an end to rattling caused by ball bearings.

The base blocks, to which the casters and lower end of the trusses are fastened.

The stretcher, in which is fastened the pedal feet

The bottom, that is fastened underneath the stretcher and base blocks.

The bottom frame and panel that serve the purpose of a door between the stretcher and key bed. This frame is held in position by buttons placed at the upper edge of the frame that are turned up against the key bed to hold it in place, or by a wooden spring fastened to the key bed that clasps the frame when in position.

The trusses. These are placed between the base blocks and key bed.

The key bed. This supports the key frame, and is one of the most important parts of the piano case. It is very sensitive to change caused by heat and dampness. If the key bed should change slightly it would effect the dip and lost motion. In some cheap pianos the key bed is made from several pieces of plank running from end to end of the case. This style of key bed if affected by the atmosphere can be given a coat of oil paint on both sides, which will prevent a great deal of the difficulty.

A key bed built on a scientific plan, has its pieces of plank tongued and grooved without being glued together. This allows each piece of plank sufficient movement for shrinking and swelling without affecting the level of the bed.

Sometimes the panels in this style key bed will become noisy unless the edges of the panels are placed between pieces of felt. If there is no felt and the panels rattle, the defect can be remedied by placing several thin wedges between the edges of the panels and the frame.

In addition to shrinking and swelling, the key bed is liable to sag, thus affecting the touch. The most practical way to avoid this is to have an iron frame that connects the cushing rail with the front and centre rails. This iron frame is firmly screwed to the under side of the key bed, that in turn is bolted or screwed to lugs cast on the piano plate directly back of of the key bed.

With this system of bracing, the keys will remain level and the touch unchanged indefinitely.

The lock or key strip is fastened down to the key bed with three or four screws that pass up through the front edge of the key bed. The key blocks are placed at each end of the key board. The cheeks are screwed and glued to the case and each end of the key bed.

The key rail passes over the keys and is held in place with screws passing down through the rail into the key blocks.

The fall board is placed over the key rail and between the cheeks.

The shelf is a flat piece of wood about six inches broad placed over the cheek and fall board. When the shelf is used the fall board is in two pieces, called the front and back fall. When open they rest under the shelf. The top frame serves as a door to the upper part of the case. This frame is furnished with carved panels or in old pianos with fret work. Sometimes the top frame is fastened in with a hinge and serves the purpose of a music desk that can be opened and closed as desired. The ends pass up from the base blocks to the under side of the top or cover. The plate is the backbone of the piano. Upon it depends most of the strength required to resist the strain caused by the tension of the strings. A plate should not be too heavy or light. The one that gives the most strength with the least bulk is the most favorable to resonance. The plate that is crowned or arched is far superior to the flat plate as it gives more space between the board and plate, thereby giving greater force to the vibrations thrown out by the board.

White wood is used in the construction of piano cases as it has but little power of resistance, owing to the fact that it is soft and easy to condense. For this reason when crossbanded on both sides there will be much less danger of cracking the outside veneer. The following should be looked at before tuning an upright piano, especially when the house is heated. See that the different flange screws are tight, that the keys are free, that the keys do not squeak, that the hammer and damper springs do not squeak, that the dampers do not rattle, that the hammers do not rattle owing to loose heads, that the pedal action does not squeak, that the flange pins have not worked out. that the action is not out of regulation, especially lost motion, back checks and let off. After the piano has been tuned it is well to give attention to voicing. The mechanical things to be looked after in the grand and square are loose flange and key rocker screws, squeaking and sticking keys. On the grand squeaking springs. Dust the sounding board and action. This can be done by taking a piece of cheese cloth and with a thin piece of steel passing the cloth underneath the strings. This will remove the dust and any substance that might rattle. See that the strings are down on the bridge as the blow of the hammer has a tendency to force the strings up from the bridge thereby causing a rattle. Regulate and voice same as in upright.

How to remove a broken tuning pin if it is broken off too short for the pin extractor to catch it. Drill a hole a little larger than the broken pin as close as possible to the pin. Then cut away the wood between the pin and hole just drilled. As soon as this is done the broken pin can be set up in the new hole and taken out. This also applies to broken screws in any of the action rails. These holes should then be plugged and a new hole drilled in the original place.

The wire used in pianos is made of steel and is given a spring temper. Unless it is evenly tempered throughout it will produce a false sound or vibrate irregularly. This will cause single wires to beat in themselves. There are several other reasons for strings being false. If the wire is a trifle larger or smaller in diameter in some portion of the string. If there is a place in the wire that receives a hard or soft temper. If the wire does not rest firmly on the bridge. If the bridge is loose on the board. The best wire manufactured will produce false sounds. Wire that is tempered too soft will stretch and not stand in tune. Wire that is too hard will stand a high strain on a straight pull but will break in coiling around the tuning pin. For this reason too hard wire is just as worthless as too soft wire. The difference in tension between hard and soft wire on No. 17 size is soft about 240 and hard about 410 pounds, 345 pounds tension is the best wire for use in the piano. This size wire when put in the piano and tuned to its proper pitch will have a strain of about 166 pounds. An easy way to remember the number of pounds tension that each string has is to add a cypher to the number of wire used, this will give No. 12 wire 120, the exact amount is 131 pounds. And No. 26 wire 260 pounds The exact amount is 258 pounds. By adding the cypher will not give the exact amount but some where near the average strain as shown above. For exact amount see page 16.

The difference between the amount of strain that wire will break at as shown by an official test and that to which it is subject to in the piano is as follows:

Official test, 13—275 lbs.	In the piano, 137 lbs.	38 47
" " 14—290 "	" " 143 "	76
" " 15—325 "	" " 150 "	47
" " 16—355 "	" " 158 "	
" " 17—410 "	" " 166 "	244

As will be seen on the last of the above the difference is 244 pounds. With this difference it seems strange that wires should break when tuned This is due to the following. Too much friction in agraffe, or the pin block, bridge too high for the agraffe thus causing too much angular bearing between agraffe and bridge, strings rusted. Pressure bar too low, thus causing too much angular bearing. Strings too long or heavy for pitch. A string 15 inches long on pitch C when first tuned to concert pitch is at breaking point, thirteen or thirteen and one-half inches is a much better length both for purity of tone and singing quality. Changing the pitch of the piano, seesawing the strings up and down when tuning. Any of the above causes will reduce the reserve strength of the wire and should be avoided if possible. Some pianos are very troublesome in regard to breaking of strings even if new wire is used. This can be remedied in some cases by letting the hammers off a little early, thus lessening the blow. This will destroy the touch of the action and is not a wise way to remedy the difficulty.

A heavier wire than was used originally will often remedy the trouble: a great many tuners make a mistake by using a lighter wire. A heavy wire will stand the blow of the hammers much better than a light one. If the length of wire between the bridge and hitch pin, and between the bridge and tuning pin be very short, the piano will not tune as well, nor stand in tune as long as if the length were greater. This is accounted for in this manner. The short string is so stiff that the least change in the sounding board or pin block caused by the weather or temperature, will disturb the portion of the string between the bridges, thus throwing them out of tune.

While if the length of string were greater it would be more elastic, thereby giving the sounding board freedom.

In putting on a new string, about three coils will be sufficient as the pins will naturally have to be driven a little further to fit tightly than when new. In new pianos the coils number about four.

How to remedy loose tuning pins.

1st See how far from the block the lower or back coil of the string is. If there is space enough between the coil and block drive the pin just enough to make it fit firmly. If there is not space enough to drive the pin, then the pin must be taken out. Take a piece of paper veneering about one-fourth of an inch in width and about two inches long. Cut the veneering with the grain and enter it in the pin hole on the lower side with the paper side against the block, and the veneering against the pin. The pin hole is now ready to receive the pin that will fit as tight as when new, if the veneering is properly placed and the pin driven in. In case the pin block is slightly split use a piece of emery cloth about three-sixteenths of an inch broad. Place the emery cloth over the crack with the emery side against the block. In this case the pin should be turned in instead of being driven. The emery cloth is placed over the crack or split in order to bring the pressure against the end wood of the block, thus avoiding any further splitting. If the pin block is badly split the only remedy is to cut out the section of the block that is split and fit in a new piece properly cross banded. The piano should be sent to the factory for such repairs. If a tuning pin is so close to the pressure bar that the tuning hammer cannot be put on the pin as far as is required, file the pressure bar enough to admit the hammer If two tuning pins are so close together that the hammer cannot be put on the pin as far as required, change the star tip for an oblong tip, which will in most cases pass between the pins; if this fails take a file and file the square of the upper end of the pins that touch the hammer a little. This will reduce the size of the pins enough to admit the hammer. Sometimes strings will not remain properly spaced, this can be remedied by cutting a slight dent in the pin block bridge with a cold chisel, then place the string in the dent made by the chisel, which will prevent the string moving against its neighbor. Copper covering gives a better tone than iron for wound strings, it is heavier than iron and is therefore not as bulky as iron.

No.	12	about	131	lbs.	No.	13	about	137	lbs.
"	14	"	143	"	"	15	"	150	"
"	16	"	158	"	"	17	"	166	"
"	18	"	174	"	"	19	"	183	"
"	20	"	192	"	"	21	"	202	"
"	22	"	212	"	"	23	"	223	"
"	24	"	234	"	"	25	"	246	"
"	26	"	258	"					

The length and size of a string should correspond with the figures as given above for the best results both for standing in tune and tone quality. If the strain should vary much on the same size wire the strings would not stand in tune. In restringing a piano first let the tension of the first string of each unison down from the highest to the lowest note, then return and lower the middle string in the same manner as the first; the third wire must then be lowered. In treating the piano in this manner all danger of cracking a plate caused by an uneven strain is avoided.

2nd Take off the wound or covered strings beginning with the largest which is called No. 1. Take a piece of wire with a loop on one end and pass it through the loop of each wound string as it is taken off. Should there be a broken string in the set, when it is reached place a piece of paste-board on the wire that the strings are strung on, with the number of the broken string marked on the pasteboard, when the string winder comes to the card he will wind a string to take the place of the broken one.

3rd Notice whether the pin block is numbered where the different sizes of wire change, if it is not, in taking off the plain wires they will have to be gauged and the block numbered where the changes take place.

4th Take a pair of wire cutters and cut the strings between the pin block bridge and tuning pin.

5th Take a medium size screw driver and pry the wire out of the eye of the tuning pin, the old coil can then be easily removed.

6th Take a brush and thoroughly clean the pin block and sounding board.

7th Notice how far the eye in the pins is from the block or plate. If the space is three-eighths of an inch or more the same pins can be used. If this space is one-fourth of an inch or less it will be necessary to bush-or use a size larger pin. In this case the pin holes must be reamed to suit the new pins.

8th If the same pins are used let them rest lightly in the pin holes. If a new set is used place them in a box with fine chalk or rosin, this will prevent the pins becoming greasy, be careful in handling the pins not to touch the threaded part of the pin with the fingers as the moisture of the hand will grease the pin and cause it to jump in tuning.

9th If there is felt under the strings see that it is in good condition before stringing. The felt that passes between the strings is placed there after the strings are all on.

10th Begin to string on the highest or shortest wire in the piano, using the same size wire as was originally used.

11th Set the strings down on the plate around the hitch pin, also on the sounding board bridge with a screw driver. Press in and close the coil on the tuning pins.

12th Weave a piece of felt between the dead portion of the strings, to prevent overtones and rattling noises.

13th Put in the wound or covered strings

How to Set a Tuning Pin.

In pianos where the pins fit very tight it is necessary to draw the strings a little above pitch and settle them back in tune.

In some pianos where the full plate is used, and there is one-half to three-fourths of an inch space between the coil on the tuning pins and the pin block, and the pin holes are not bushed in the plate, the pins will spring a great deal and must be brought up above pitch and set back in place to stand in tune.

In some pianos where the pins turn easy they wil. not stand setting of the pins as a slight pressure back will start them on the down turn, which will prevent the piano standing in tune. If the pins are loose they should be driven in enough to make them fit tightly Pins can be driven until the coil almost touches the block or plate. After the pin is set a test blow must be given to equalize the tension of the strings. If the pins are well set and the tension of the strings equalized, it is all the tuner can do to make the piano stand in tune.

Reasons why pianos do not stand in tune as well as they should. The strings too long or heavy for the pitch, thereby causing too much strain on the wire and frame. In pianos with a partial plate the pin block too broad or too much wood between the pins and the plate on which the block rests. The wood of the pin block too soft. The wire too soft and the plate too weak to stand the strain. The strain caused by the tension of the strings not being properly balanced.

The pins turn too easily, either because they were not put in solid enough or the block was not well seasoned.

The block split. If a pin block splits it will most always split at the top or back row of pins as the pressure of the other pins will prevent it splitting at the lower or front row of pins. A cheap piano very often is not well balanced, that is, some part of the frame is not strong enough to stand the strain of the strings. Therefore one part of the piano will pull out another after it has been tuned.

When is it necessary to restring? When the strings have rusted enough to damage the tone. When the wire has lost its life and is constantly breaking.

Coleman's Aeolian attachment consists of a set of reeds that can be used with or without the piano. This arrangement is operated in the following manner. On the under side of the front of the key is fastened a row of regulating screw eyes, one to each key. On pressing down a key this screw eye comes in contact with the valve push pin, thus opening the valve and allowing the air to draw through the reed and set it in vibration. The reeds, valves and push pins are set into a place cut out of the key bed directly under the front end of the keys. This aperture in the key bed is deep enough to allow the reed, valves and push pins to rest a trifle below the level of the key bed, in order not to interfere with the taking out and putting in of the piano action.

There is a cover placed over the reeds and hinged at one side, in order that the reeds may be easy of access, when dust gets into them and prevents them from speaking. Underneath the key bed are placed the bellows and exhauster. These are operated by a long pedal foot fastened in the lyre by which means the air is pumped out of the bellows. In addition to this pedal there are three others. The damper pedal, the soft pedal and the swell pedal for the reeds. If the valves get out of order they can be repaired by taking the screws out of the frame that holds the reeds. Remove the frame, directly under which are the valves. In the key block at the bass is placed a stop, the use of which is to raise the hammers against the strings in order to prevent them striking the strings, and holding them in that position as long as the stop is on, thus making it a dumb piano. By pumping the organ pedal and using the keys, just as when using the piano, the effect of the organ is obtained. This organ attachment can be used with or without the piano. In some pianos with this arrangement, before the action can be taken out the soft pedal action will have to be disconnected. The levers of this action are placed at each end of the key board on the inside of the piano and are disconnected by lifting them up at one end and slipping them out of the groove in the brackets of the hammer rail.

When is it necessary to voice? When the hammers have become hard enough to produce a harsh metallic tone. In voicing felt hammers that are very hard and require deep pricking or tempering, not more than two needles should be used in the voicer, as with more than this number the difficulty cannot be reached. The best style of deep voicing is to force the needles toward the centre of the head just as the spokes of a wheel enter the hub. For surface voicing of felt hammers, also capped hammers, from four to five needles are used, as this style of voicing is simply on the surface of the hammer, especially is this true of capped hammers. The needles should never go through the capping. Voicing of hammers on the surface only will not last but a short time and does more harm than good. The condition of the hammers has a great influence on tone. Some hammers are made of felt that is soft and elastic while others are made of felt that is hard and stiff. A set of hammers cannot be properly voiced, if they need surfacing, as the striking point is too large and the indentations in the hammers caused by the wire cutting into the felt so deep as to prevent the desired tone. The hammers should first be shaped as near like new as possible before voicing. This means giving the hammer a round striking point instead of a flat or sharp one. A hammer should not be either too light or too heavy, as one gives a tinkling and the other a clumsy tone.

The holes in the heads should be bored in such a manner as to cause the hammers to strike the strings at right angles. If such is not the case the hammers will shift up or down on the strings as they strike them, thus interfering with the freedom and solidity of the tone. Again if a hammer is too heavy it will be too slow in its rebound from the strings, thus interfering with their vibrations.

When is it necessary to put on a new set of hammers? When the felt is worn so thin as to produce a tinkling and metallic tone, that cannot by remedied by voicing.

How to order a new set of hammers.

Send to the hammer maker the first and last head where the angle of the boring of the heads changes. Also the number of heads in each section.

How to hang hammers. If not experienced in this line of work begin with the second hammer in the bass. Take off this head with hammer extractor and immediately put back the new head that belongs in this part of the action without using any glue. To see if the hammer will hang in line, and strike the strings at the same point as old head did. Use a straight edge on the top of the hammer both on the felt and wood part of the head to see if they are in line with each other. If so take off the head and put it back again, this time using glue. When the hammers are received from the hammer maker be careful not to mix them. If they are not numbered begin at the largest hammer and number it one, and the next two, etc., until number eighty-eight is reached. This prevents mixing the hammers.

In shaping felt hammers for capping they should be surfaced or cut down enough to remove all traces of the old indentation caused by the hammers striking the strings, and the striking point should be rather sharp and enough felt should be cut off the front and back of the hammer to insure the hammer not being any larger than it was originally. In cases where the felt has been cut through to the wood, a piece of thick capping leather should be used in order to get the proper tone. If the caps are drawn over the heads too tight the tone will be too harsh. This can sometimes be remedied by running a darning or knitting needle between the cap and felt. This will stretch the cap some thereby loosening it a little. If the caps are too loose the tone will be too soft. This can be remedied by drawing the cap tighter. The nap side of the leather must come in contact with the strings.

In regulating and repairing a square piano the tuner will need a system of marking keys that require special attention. A piece of chalk is best suited for this as it can be easily erased when the difficulty is removed.

The characters used by most tuners are these: — | + T X O > <. There is no fixed meaning to the above as some tuners will use this sign — if a jack is too high, others may use it for a blocking hammer, etc. Each tuner has a meaning of his own that applies to the different characters. If the damper lifter wires in the square piano are so low as to rest on the cushion on the tail of the key they should be raised enough to allow the keys passing under them when the action is taken out and put back. This is done by means of the lower button on the lifter wire. Turning this button down raises the lifter wire above the key. If this button is too high it will hold the lifter wire against the damper lever and hold the damper from the strings, thus allowing them to sound after the finger has been removed from the key. The lifter wire should be so regulated as to have lost motion between the damper lever and lifter wire and lifter wire and key.

In regulating and repairing the square piano, 1st See that the action is in proper position. 2nd See what condition the front and centre rail punchings are in. If moth eaten replace them with new punchings Before putting in new punchings thoroughly clean the different rails and parts of key frame. If the felt is badly moth eaten, it will be wise to take a brush and go over the pins and rails with benzine, in order to destroy moth eggs. 3rd Level up the keys. To do this put about three paper punchings on each centre pin. These paper punchings should be of three thicknesses, newspaper, writing paper and postal card. By placing these on the centre rail, all high keys can be lowered without difficulty. Then place felt punching on top of the paper. Use a straight edge made of light material as pine or white wood and long enough to reach from the lowest to the highest key. 4th Regulate the dip, which in the American square is three-eights of an inch, and in the Old English two-eighths. 5th Space the hammers. 6th Regulate the lost motion or set up the jacks. 7th Regulate the let off one-eighth of an inch from the wound strings up, and about three-sixteenths from the wound strings down. 8th Regulate the back checks to catch the hammers as high as possible. Such is the case when the space between the back check and hammer is one-sixteenth of an inch as they pass by each other when the key is lowered slowly. 9th Regulate the dampers.

Old English square. If the fly or jack does not get under the under hammer. 1st See that there is lost motion enough. This is regulated by putting a thin piece of cloth under the under hammer felt to hold the under hammer high enough to allow the fly to get under, the thickness of a piece of paper is sufficient. 2nd See that the end and back of the fly are well black leaded. 3rd See that the fly spring is not too stiff. If this spring is too stiff it holds the fly against the under hammer with too much force, thus preventing it from getting under.

In some old pianos the end of the jack tapers a little instead of being square. This tapering of the jack was to make it take a firmer hold of the hammer knuckle, thus increasing the force of the blow of the hammer. To-day this is not necessary as the actions are so constructed that more power is obtained with much less friction on the knuckle and let off screw punching. In repairing old pianos with a tapering jack, if the leather on the hammer knuckle wears out in a short time the best remedy is to file the end of the jack square and re-black lead it, then recover the butt which will wear for years. In repairing the jack cushion after the butt has been covered be careful and not get it too thin or too thick. The jack must get under just far enough to bite. If it gets under too far it will release with too much friction and cause a heavy touch. It will also cause the action to kick when the jack escapes.

Repairing Pianos.

Before giving an estimate on the expense of repairing a piano, it is necessary for the tuner to examine the case, plate, strings, bridge, sounding board, keys, action and pin block. Also the style, make and age of the piano. If the piano is one hundred or more years old, the different parts of the action will most likely be hand made. In this case if there is anything broken or missing the tuner must bring his mechanical skill into practice and reproduce the defective parts. This requires a great deal of time and must be figured, on the estimate of the cost. If the piano is of modern make, any part of the action can be duplicated by sending to the maker of the action. In this case figure on expense of material and labor of putting together. In rebuilding a piano the tuner must not give the owner of the piano the impression that it will be as good as a new piano, as this is impossible. It is much wiser to be moderate and not claim too much. There have been hundreds of patents granted to action makers. This means a great many styles and complications that tuners have to contend with.

In leveling the keys the end keys should be set as guides, by placing dip blocks under them. Let the blocks rest on the front rail and against the under side of the key. This will prevent the keys from dropping when the straight edge is used. In rebushing a flange first remove the old bushing, then take a new strip of bushing cloth that is just broad enough to have the edges firmly meet without lapping over, five-sixteenths of an inch is the average width. Taper one end of the strip of bushing in order that it may be entered in the flange,after which draw the cloth to within one-fourth of an inch of the end. Put a little glue on the cloth, then draw the cloth through enough to place the glued part in the flange, after which insert a flange pin, to press the bushing against the flange. As soon as the glue sets the pin can be removed and the bushing cut off. It is then ready to be pinned to its part. In putting in the bushing care must be taken not to get any glue between the edges of the cloth.

How to clean ivories that are very yellow. Take out the black keys and fasten down the white keys with a long strip of wood, running from one end of the key board to the other, between the key buttons and ivory tails, then take number one sand paper and fasten it to a block of wood about six inches long and four inches broad and about one inch thick. Then take the block and sandpaper the ivories lengthwise until the yellow is removed. Never rub across the keys. Second, take another block of wood the same size as the first. Cover this block with a white piece of felt wet with water and put on some whiting and alcohol and rub the ivories until polished.

All pianos cannot be tuned by the same method, as some require a special treatment owing to the difference in tone, in strings, in boring of the pin block. Whether the pins are well fitted to their holes or not, in the amount of friction caused by the pressure bar or agraffe and the plan or scale of the piano. Therefore in tuning old pianos it requires an entirely different practice from that of a new piano.

Mozart's Grand was a three unison piano and had but five octaves, which was the standard key board of that day. About the year 1778 the sharps and flats were made of ivory and the naturals of ebony. The strings were short and light, pitch C measuring but eleven and one-half inches. In some makes of to-day pitch C measures fourteen and one-half inches with much heavier wire. The bass strings were made of brass. The tension on this piano was 14,360 lbs. when tuned to pitch A 421.3.

In practicing on a piano continually the ear becomes accustomed to its defects so that the piano does not sound badly to the player and sometimes after it has been tuned will say it does not sound as well as before. This is discouraging to the tuner and the only remedy is for the player to train the ear to a correct pitch.

Every noise has its own characteristic and can be readily located by the experienced tuner. If it is a metallic sound it is usually caused by some metallic portion of the piano being loose or not properly adjusted. If it has a chucking sound it is in the action. A noise at a distance from the piano will not be instantaneous.

Touch

An action with a heavy touch can sometimes be made lighter by freeing the keys, that is the guide and centre pin punctures. Care should be taken not to free them enough to cause the keys to rattle, as this evil is almost as bad as a heavy touch. If heavy damper springs are used this resistance can be overcome by lessening the lift of the dampers. Regulate them to lift one-eighth of an inch instead of two-eighths. A lift of one-eighth of an inch will not interfere with the strings vibration but will make the touch very much lighter if heavy springs are used. If there is too much lead in the tail of the key take out some. This can be done by placing key lead over an opening and with the use of the tip wrench the key leads can be driven out, always place the wrench on the small end of the lead as key leads are conical in shape. When the hammers are hard thus causing a metallic tone the touch seems easier.

When the hammers have been voiced the touch seems harder as it requires more effort to produce the tone. If the hammers are large the touch is proportionally heavy.

If hammers rebound on the jacks see if they let off and if there is sufficient after dip to free the jack. If not look at the following. 1st Level keys. 2nd Three-eighths of an inch dip. 3rd Lost motion taken up. 4th Bridles with at least one-fourth of an inch slack. 5th Back checks as close as possible without causing blocking of hammers. 6th Let off at one-eighth of an inch. 7th Stroke of hammer short enough that when the above are all right there will be sufficient after dip to force the jack from under the hammer knuckle. If there is sufficient after dip and hammers rebound it is evident that hammer springs are too weak or that the shanks lean toward the strings when they are held against them. Block rail or jack check may also interfere with the escapement of jacks.

Table giving number of vibrations for each note of the chromatic scale in the one lined octave when tuning equal temperament at French pitch.

					Scale showing increase of vibrations.		
1	lined	C'	258'6	1	lined	C'	
1	"	C' sharp	274'0	1	"	C' sharp	15'4
1	"	D'	290'3	1	"	D'	16'3
1	"	D' sharp	307'6	1	"	D' sharp	17'3
1	"	E'	325'9	1	"	E'	18'3
1	"	F'	345'3	1	"	F'	19'4
1	"	F' sharp	365'8	1	"	F' sharp	20'5
1	"	G'	387'6	1	"	G'	21'8
1	"	G' sharp	410'6	1	"	G' sharp	23'0
1	"	A'	435'0	1	"	A'	24'4
1	"	A' sharp	460'9	1	"	A' sharp	25'9
1	"	B'	488'3	1	"	B'	27'4
2	"	C''	517'3	2	"	C''	29'0

In the grand piano if the back check does not hold the hammer in its rebound from the strings and the repetition lever spring is not too strong it can be remedied by making cross scratches with a sharp pointed instrument on that portion of the hammer that comes in contact with the back check. This will prevent the hammer slipping away from the back check.

If the flange pins work out in any part of an action before replacing new and a trifle larger pin examine the part that holds the pin. If the wood is not split, a half size larger pin can be used, if it is split exchange the damaged part for the highest note in the piano, as this note is used so seldom that the defective piece will work indefinitely.

If the moulding is loose that is used as a finish around the edge of the plate. it will cause a rattling noise. This can be remedied by setting the brads in with a small punch.

If the escutcheon is loose it will cause a rattling noise. This is remedied by sticking the end of a screw driver in the escutcheon and tightening it.

A rattle is sometimes caused in the grand or square piano where the lyre is braced with iron or wooden rods this can be remedied by wedging pieces of felt between the rods and lyre. In the grand if the key blocks do not rest firmly on the key frame slides they will rattle against each other. This is noticed only in the lower and higher octaves and can be remedied by tightening the screws in the key blocks. If this fails, loosen the screws and place a piece of postal card between the key frame and key bed, a few inches to one side of the key blocks, then tighten key block screws. This will cause the parts to rest firmly against each other, and thus prevent rattling.

UPRIGHT ACTION.

Keys Stick.

1. When the key strip is too close to the keys.

2. When the key punctures are too small for the guide and centre pins.
3. When the key is too close to the bracket post or key blocks.

4. When any foreign substance is wedged between them.
5. When the guide pin touches the front or back end of the puncture in the key.

6. When they require spacing.

7. When they are warped.
8. When the key is not sufficiently weighted.

9. When the key leads touch each other.
10. When the key frame or bed twists or warps

UPRIGHT ACTION.

Keys Stick.

1. Test: Pull out on the key strip; if key returns. Remedy: Place a narrow piece of card-board on the key bed against the front rail, directly under the key that sticks.
2. Test: No side movement to the key. Remedy: Enlarge puncture with key plyers.
3. Test: Rubbing of key against the bracket post or key blocks. Remedy: Plane the key at place of contact.
4. Remove keys.
5. Test: End of puncture marked by guide pin. Remedy: Cut out the portion of key marked by the pin.
6. Test: Centre pin loose in centre pin rail. Remedy: Remove pin and make cross filings on the lower end of the pin. Cover that end of pin with glue and replace the pin so that the polished portion of the pin will come in contact with the bushing in the key button. If the pin is not loose in the rail space the key by bending the pin.
7. See No. 3 of this page.
8. Test: Ascertain condition of the action by lifting the Jack rocker. If that returns promptly the action is all right. Then if the key having proper side movement, still fails to return promptly, it is not sufficiently weighted. Remedy apparent.
9. Drive leads back, if loose spread.
10. Test: Any rubbing of the keys against the pins. Evidence of this seen on the ends of the guide pin puncture. Remedy as stated in No. 5.

11. When the black keys touch the key rail or name board.

12. When the key rocker touches the next key.

13. When the tail of the key touches the plate.

14. When the key leads have become corroded.

15. When the back check strikes the hammer of the next semi-tone above.

Keys Rattle.

1. When the key punctures are too large for the centre and guide pins.

2. When the bushing of the punctures has become hard.

11. Test: Black keys touching fall board or key rail. (This applies also to grand and square.) Remedy: Glue a piece of felt on that portion of the key blocks which would result in setting back the fall board or key rail.

12. Test: Key rockers touching each other. Remedy: Space the rockers and tighten the screws. (Look out for lost motion.)

13. Remedy: Cut off a little from the end of the key.

14. Remove corrosion with a file.

15. Test: Hammer of semi-tone above moves when key is lowered slowly. Remedy: Bend back check wire. (This refers to the grand action.)

Keys Rattle.

1. Test: Key falling of its own weight on being raised a little. Remedy: Pass a needle threaded with No. 25 linen, up through the centre pin hole until the ends of the thread are within a half inch of the hole. Hold the ends while the key is replaced. Cut the thread at top of key button.
   (*b*) Test: In case of guide pin. Too much side motion to the key. Remedy: Reduce the extra motion by turning the guide pin. Always use key spacer.
   (*c*) Test: Same as (b), but due to bushing in key button being worn. Remedy: Rebush or wedge by making a small cut in key button at side of bushing and inserting a small piece of wood.

2. Remedy: Rebush or scrape a nap on the old bushing.

3. When the key button or piece of wood that is sometimes set in on the underside of the key snaps.

4 When the bushing of the guide pin puncture rubs against the next key.

5. When the key leads are loose.

6. When the key is slivered

7. When the key rocker screws are loose.

8. When the key touches the bracket post.

9. When any hard substance is lying on the punchings or cushion.

10. When the key returns to its proper level, it may come in contact with glue that has soaked through the felt on the key rail.

11. When the guide pin punching has been destroyed by moths.

12. When the ivory is loose.

13. When the key frame is loose.

14. When the felt on the rocker has become hard.

3. Test: Key button loose. Re-glue. Test: Piece of wood on bottom of key snaps when key is sprung. Remedy: Saw through the ends of the piece of wood being careful not to saw into the key.

4. Remedy: Smooth the bushing. (This refers to black keys only.)

5. Spread the key lead by laying the small end of the lead against the flat side of a pair of plyers and striking the other side of the lead with a T hammer. These leads are conical. Spread the large side.

6. Smooth with a knife.

7. Tighten screws and look out for lost motion.

8. Use plane.

9. Remove substance.

10. Remove the glue.

11. Renew the punchings; look out for dip.

12. Remove the old glue from the ivory and key and reglue; clamp the ivory while the glue is setting. or wind No. 25 linen thread around the key and ivory. This will answer the purpose of a clamp. The Ivory can also be kept from warping by moistening the upper surface of the ivory while the glue is setting.

13. Test: Rattle ceases when keys above and below those rattling are held down with some force. Remedy: Tighten key frame screws.

14. Prick with voicer or rough with felt scraper.

Keys Squeak.

1. When the bushing of the guide pin puncture has become hard.
2. When the bushing of the key button has become hard.
3. When the felt on the key rocker is gritty, or has become hard.

Jack-Rocker Parts Stick.

1. When the jack-rocker flange bushing is too tight.
2. When the jack flange bushing is too tight.
3. When the jack spring is too weak.
4. When the bridle wire strikes the back check wire of the next jack-rocker above.

Jack-Rocker Parts Rattle or Click.

1. When the bushing is worn in extension guide.
2. When the bushing is worn in extension.
3. When the felt is hard on the jack-rocker.
4. When the felt on the back check is hard.
5. When the felt is worn from the back check.
6. When the bridle wire strikes the back-check wire, or is loose in the jack-rocker.
7. When the bridle tip is loose in the bridle wire eye.
8. When the lower coil of the jack spring rests on the glue that holds the spring.
9. When the flange pin of the jack works out and touches the pin above or below.

Keys Squeak.

1. Remedy: Rough the bushing, or put on a little tallow.
2. Remedy: Same as No. 1
3. Rough the felt on the key rocker, put on some powdered graphite. (Never use grease on the key rocker.

Jack-Rocker Parts Stick.

1. Remedy: Ream the bushing. To do this push the pin through a little, hold it against some rough, hard surface, (as a copper cent) with sufficient force to push it back into its usual position while moving the flange forward and backward. Ream both sides in this way.
2. Use a drop of benzine on the bushing.
3. Put in new spring or stiffen the old spring by spreading the coils.
4. Bend the wire into position.

Jack-Rocker Parts Rattle or Click.

1. Put in larger pin.
2. Put in larger pin.
3. Rough the felt.
4. Prick the felt with voicer.
5. Renew the felt.
6. Put glue on threaded portion of wire and screw back again.
7. Put a new tip made of felt or action leather on the top of the old tip.
8. Put a piece of felt between the spring and glue.
9. Put in a larger pin.

10. When the spoon strikes the damper rod.

11. When the back-check wire strikes the regulating screw-rail.

12. When the jack flange is unglued.
13. When the back check strikes the top frame.

14. When the felt on the jack check is worn into the wood or unglued.
15. When the flange screws are loose.
16. When the punching is worn from the regulating button.
17. When the jack strikes the block rail screws.
18. When the jack strikes the regulating screw rail bracket.

Jack-Rocker Parts Squeak.

1. When the different bushing joints become hard.

Dampers Will Not Damp Properly.

1. When the bushing is too tight.
2. When the spring is too weak.
3. When the damper does not rest evenly on the strings.

10. Bend the spoon so it will not strike the rod, or file it where it comes in contact with the rod.
11. Put the rail back into position and see that the heel of the jacks come in contact with the let off screws.
12. Reglue.
13. First fix the lost motion. If this does not remedy the fault see if the back check can be bent in, in order to catch the hammer closer to the strings. If this is not sufficient set the top frame out by gluing pieces of felt on the top and bottom of the top frame where it rests against the case.
14. Reglue the old felt or put in a new piece.
15. Tighten screws.
16. Put on new punching.
17. Set the jack over by papering jack-rocker flange.
18. Set the jack over by papering jack-rocker flange.

Jack-Rocker Parts Squeak.

1. Dip a toothpick in a good grade of machine oil and touch it to the end of the pin that squeaks.

Dampers Will Not Damp Properly.

1. Test as stated on page 37, Jack-rocker parts stick.
2. Put in a new spring.
3. If the damper does not touch the first or third string, adjust the damper on the wire and tighten set screw in damper block. If the upper edge of the damper felt does not touch the strings, bend the damper wire toward them. If the lower edge of the felt does not rest on the strings bend the wire in the opposite direction. In bending the damper wire for the above faults, the regulating instrument must be placed about one-fourth of an inch below the damper head.

4. When the felt has lost its elasticity.

5. When the position of the damper has not been placed in the exact damping point of the strings.
6. When the damper does not follow the strings if they are pressed toward the sound board.

7. When the dampers are too small.

8. When the lever rests on the damper rod.

9. When the lever rests on the spoon.

Dampers Rattle.

1. When the bushing has worn too large for the pin.
2. When the spring is too weak.
3. When there is any hard substance on the surface of the felt, or the felt is partially unglued.
4. When the set screw of the damper block is loose.
5. When the felt is hard.
6. When the damper wire is loose in the lever.
7. When the damper head strikes the action brackets.
8. When the damper strikes the hammer head.
9. When the flange screws are loose.
10. When the felt is worn from the damper lever so that the spoon strikes the wood.

Dampers Stick.

1. When the bushing is too tight.

4. Scratch the felt from the centre toward each end carefully. Use felt picker for this.
5. This is possible but very unusual. Remedy is difficult and impracticable outside of factory.
6. First: Can the key be lowered about half way before the damper lifts, if not bend the spoon toward the main rail a little. Second: Can the pedal be lowered about ¼ of an inch before the dampers begins to lift, if not put some lost motion in pedal action.
7. This cannot be remedied unless a new set of larger or heavier dampers is used.
8. See second remedy of No. 6, Dampers will not damp properly.
9. See first remedy of No. 6, page 41.

Dampers Rattle.

1. Use larger flange pin.

2. Put in a new spring.
3. Remove hard substance and reglue felt.

4. Adjust block and tighten screw carefully.

5. See No. 4. of Dampers will not damp.
6. Take wire out, glue the thread and screw back.
7. Glue or tie a piece of felt on the bracket where damper head strikes.
8. Lower damper a trifle.
9. Tighten screws.
10. Take off felt and reverse it.

Dampers Stick.

1. See No. 1 of Jack-rocker parts stick, page 37.

2. When the spring is broken.
3. When they rub against each other.

Dampers Squeak.

1. When the spring wears nap from the felt.
2. When the nap is worn from the bushing joint.

Order of Regulating Damper.

1. The action must be in the right position and firmly secured to the action bolts with action brackets resting on posts or in cups.
2. Adjust the pedal action so that the damper rod may nearly touch the damper levers when at rest.

3. Adjust the height of the dampers.

4. Adjust the line of the dampers.

5. The damper wire must also be so adjusted that the lower edge of the damper felt will touch the strings at the same instant that the upper does, otherwise the damping of the strings would be seriously affected.

2. Put in a new spring.
3. Space them by adjusting them on the wire and if necessary bend the wire.

Dampers Squeak.

1. Rough felt and black lead.
2. See No. 1 of Jack-rocker parts squeak, page 39.

Order of Regulating Damper.

1.——

2. The lost motion of the pedal action is adjusted in some pianos by adding or taking out punchings on the lower end of the pedal sticker, in others by raising or lowering the nut of the bolt passing through the pedal foot. The pedal foot should have a motion of about one-fourth of an inch before the dampers lift.
3. The height of the dampers is adjusted by loosening the set-screw in the damper block and tapping the damper up or down until it is in line with the straight edge. Then tighten set screw (without too much force) carefully.
4. The line of the damper is adjusted by loosening the set-screw and twisting the damper on the wire until it is in line with the strings.
5. The damper wire is adjusted so that both edges of the felt may rest on the strings, by bending the wire a quarter of an inch below the damper head to make the upper edge of the felt touch the strings: to make the lower edge touch bend away from the strings. This is done by bending the wire close to the head.

6. Space the dampers by bending the wire close to the damper head.
7. The damper wire must be so adjusted that all the dampers will leave the strings at the same instant after the pedal foot has been lowered one quarter of an inch. This lost motion is necessary for perfect damping.

8. The lifting of the damper when the pedal is used is controlled by the damper wire. The spoon has no more to do with the lifting of the damper in this case than the damper wire has to do with the lifting of the damper when the key is used.
9. The lifting of the damper when the key is used is controlled by the spoon. This is so regulated that the damper will leave the strings when the hammer has travelled one half the distance to the strings.

Hammers Stick.

1. When the bushing joint is too tight.

2. When the heads rub against each other.

3. When the bridle tape is torn.
4. When the head rubs against the action bracket.
5. When the spring is displaced
6. When the shank twists.
7. When the flange pin has worked out so that the hammer is hinged only on one side.

6.——

7. The damper wire is adjusted so that the damper will lift when the pedal is lowered a quarter of an inch by bending the wire a quarter of an inch above the lever. To make the damper lift more bend the wire away from the strings, to make it lift less bend the wire toward the strings.

8.——

9.——

Hammers Stick.

1. If there is a butt plate put in smaller pin, if no butt plate see No. 1, Jack-rocker parts stick, page. **37.**
2. Space the hammers: if they spring back to their former position glue a narrow piece of paper on the lower corner of the flange, if the hammer rubs the hammer above glue the paper on the right hand corner of the flange, if it rubs the next hammer below glue the paper on the left hand corner of the flange.
3. Put in a new tape.
4. Space the hammer.
5. Replace.
6. Use alcohol lamp.
7. If there is a butt plate put pin back and tighten butt plate screw. If there is no butt plate put in a trifle larger pin.

Hammers Rattle.

1. When the bushing is too loose.
2. When the shank is loose in the butt.
3. When the head is loose on the shank.
4. When the back stop stem is loose in the butt or back stop.
5. When the butt plate is loose.

6. When the flange screws are loose.
7. When the hammer spring touches the butt plate.
8. When the coils at the upper end of the hammer spring touch each other lightly.

9. When the hammer flange pins have worked out and touch each other.

10. When the hammer heads strike each other.
11. When a spring is displaced.
12. When the jack cushion is moth eaten.
13. When metallic flange is used if bushing is loose in the flange.

Hammers Squeak.

1. When the bushing becomes hard.
2. When dust and grit have worked under the hammer spring.

Hammers Rattle.

1. Put in larger pin.
2. Reglue.
3. Reglue.
4. Reglue.

5. See that the flange pin has not worked out, if not tighten butt plate screw.
6. Tighten screws.
7. Bend the lower end of the spring so it cannot touch the butt plate.
8. Test: Push the hammer rail toward the strings, if on striking the key the rattle stops, it proves that the noise comes from the hammer spring. To locate the noisy spring, take a group of hammers and hold them against the strings while the key that rattles is struck. Repeat this until a group is found that will stop the rattle, then take the hammers separately until the one that causes the noise is found. Remedy: Separate the coils at the upper end of the spring with a screwdriver.
9. Test: Move the hammer butt of the semitone above to the right or of the semitone below to the left, if either stops the rattle. Remedy by replacing the pin of hammer that rattles.
10. Space the hammers.
11. Replace the spring.
12. Renew cushion.
13. Rebush flange.

Hammers Squeak.

1. See No. 1 of Jack-rocker parts squeak, page **39.**
2. Rough felt and black lead.

Hammers Block.

1. When the dip is too deep.

2. When the lost motion regulator is too high, hammers wink when the tail of the key is tapped.

3. When the back check is too close.

4. When the regulating screw is too high.

Hammers rebound on the hammer rail only when the back check does not check them. It would be impossible for the action to repeat well if such was the case.

Hammers Rebound on the Jack.

1. When the dip is too shallow to free the jack.

2. When there is too much lost motion between jack and hammer knuckle.

3. When the bridle is too tight.

4. When the back check does not catch the hammer high enough.

Hammers Block.

1. Measure dip at the front edge of the key if more than than three-eighths of an inch. Put punchings on the front rail until it measures only three-eighths of an inch.
2. Lower the lost motion regulator until there is just lost motion enough to allow the jack to get under the hammer knuckle.
3. Bend back the back check wires enough to prevent blocking.
4. Lower the regulating screw until the hammer lets off at one-eighth of an inch from the strings.

Hammers Rebound on the Jack.

1. Measure dip at the front edge of the key and if it is not three-eighths of an inch take out punchings until the required depth is obtained.
2. Raise the lost motion regulator. See No. 2 of Hammers Block, page 49.
3. In this case there is too much lost motion, but the bridle being tight covers or conceals it; before the lost motion can be fixed the bridle wires must be bent in enough to give the bridle tape a quarter of an inch slack. To regulate lost motion see No. 2 of Hammers Block, page 49.
4. Bend in the back check wires in order to catch the hammers closer to the strings. Care must be used not to bend them too much as that would result in blocking the hammers against the strings.

5. When the stroke of the hammer is too great.

6. When the back check does not hold the hammer.

Hammers Rebound When the Action is Worn.

1. When the leather on the butt knuckle has worn so that it forms a ridge, which will prevent the escapement of the jack.
2. When the hammer spring is not of sufficient strength to move the hammer back.

3. When the black lead is worn from the jack.
4. When the hammer shanks lean toward the strings if the hammers are held against the strings.

Reasons why the Jack does not get under the Hammer Butt Knuckle.

1. Key rocker or capstan screw is too high.

5. Shorten the stroke by gluing pieces of felt under the hammer rail cushions. If the stroke is over two inches shorten it to 1⅞ of an inch. If 1⅞ shorten to 1¾ of an inch as the length of stroke is from 1¾ of an inch to to two inches. Shortening the stroke will throw lost motion in the action. This must now be taken up as stated in No. 2 of Hammers Block, page 49. The stroke is measured from the first plain wires above the wound strings back to the hammer.
6. Test. Back check strikes lower edge of back stop. Remedy: Bend back check wire in order that it may catch the upper and lower edge of back stop at the same time.

Hammers Rebound When the Action is Worn.

1. Smooth the leather with a sharp knife or sand paper file.
2. This cannot be remedied unless a new set of heavier springs were put in. This is almost as bad as having no hammer spring at all as is sometimes the case in low grade or cheap pianos.
3. Re-black lead the jack.
4. This is serious and will only be found in the very cheapest pianos. The only remedy for this fault is to set the action closer to the strings. This necessitates the entire regulation of the whole action. It would be impossible for an action to repeat well under such circumstances.

Reasons why the Jack does not get under the Hammer Butt Knuckle.

1. Lower the lost motion regulator just enough to allow the jack to get under the knuckle.

2. The jack spring too weak broken or displaced.
3. The bushing joint too tight.
4. The jack check or felt too far from the jack. This allows the jack to catch on the leather of the hammer butt.
5. The hammer butt knuckle worn so that it forms a small ridge on the surface of the leather
6. The back-check may not catch the hammer high enough.
7. The flange pin partially out.
8. The flange unglued.
9. The bridle too tight or caught on the end of the jack. (If the bridle is too tight by pressing on the jack-rocker the jack will return.)
10. The black lead worn from the jack.

Order of Regulating.

1. Level up keys.

2. Regulate the dip.

3. Regulate the lost motion.

2. Stiffen the old spring or put in a new one.
3. Use a drop of benzine on the bushing.
4. Reglue.

5. Smooth the leather with a sharp knife or a sand-paper file.
6. Bend in the back check wire a trifle but not enough to cause blocking hammers.
7. Replace with larger pin.
8. Reglue.
9. Bend in.

10. Reblack lead.

Order of Regulating.

1. Level keys by adding or taking out paper punchings on centre rail; always place paper under the felt. Before commencing to level keys see that the weight of the jack-rocker is resting on the lost motion regulator. Bridle being too tight would prevent the Jack-Rocker or extension from resting on the lost motion regulator, or the spoon if it is too close to the main rail. If the key bed has sagged in the centre raise centre rail by placing paste board between the cross pieces of the key frame and bed.
2. The dip is regulated by taking out or putting in front rail punchings in order to make dip of key three-eighths of an inch deep.
3. In regulating lost motion watch the back-check. When this has a motion of one-sixteenth of an inch before the hammer starts while the key is lowered a trifle there is sufficient play to allow the jack to get under the hammer knuckle. This it must have in order to repeat well, especially in old pianos.

4. Regulate the bridles.

5. Regulate the back checks.

6. Regulate the spoons.

7. Regulate the let off.

Pedals Squeak.

1. In the pedal foot.
2. In the pins that pivot the levers.
3. In the spring underneath the lever.

4. In the guide that the upper end of the sticker passes through,
5. In the damper rod hinges
6. Between the felt on the damper lever and the damper rod.
7. In the damper spring channel.

4. There is no fixed length of bridles among piano manufacturers. Some leave one-forth of an inch slack in the tape, others one-half of an inch or more and some do not leave any. One-fourth of an inch is the safest. The slack in bridle is regulated by bending the bridle wire.

5. The back checks in some pianos are regulated to catch the hammers at one-half of an inch from the strings, in others at three-fourths of an inch.

   Regulate the first and last back check of each section to the required distance. The remaining back checks are brought in line with the straight edge. The back checks are regulated by bending the back check wires.

6. The spoons are regulated by bending them toward the strings to make the damper lift more and by bending toward the main rail to make the damper lift less. Regulate the spoons to lift the dampers one-fourth of an inch from the strings when the key is down.

7. Regulate the hammers to let off at one-eighth of an inch from the strings. This is done by turning the let off screw.

Pedals Squeak.

1. Use tallow or black-lead.
2 Use tallow or black lead.
3. Place a piece of action leather between the spring and lever.
4. Use tallow or crayon pencil.

5. Use tallow or black lead.
6. Use crayon pencil.

7. Use tallow or stove polish in spring channel.

Jars--Metallic.

1. The strings loose on the bridge.
2. The strings do not bear properly in agraffe.
3. Bearing or pressure bar does not bind enough.
4. The strings touch each other from the upper bridge to the tuning pin or from the lower bridge to the hitch pin.
5. The bridge pins loose.
6. The bridge checked.
7. Some foreign subtance between the bridge and the strings.
8. The damper block may touch the strings between the break of the scale in the treble and bass.
9. It may be that the strings are too close to the brace of the plate.
10. The end of a key touches the strings.
11. In pianos with old English action the damper wire may touch the strings.
12. Screws or bolts loose in the plate.
13. Castors do not rest evenly on the floor.
14. The hammer spring if partially spiral.
15. The jack spring if the lower coil touches the glue.
16. Flange pins, if they touch each other.
17. Bridle wire strikes the back check wire or is loose.
18. Bridle tip jars in the bridle wire eye.
19. Pin or some other hard substance on the sounding board.
20. Lock may be loose.
21. Winding of bass strings loose.
22. Spoon strikes damper rod.

Jars--Wooden or Chucking.

1. Hammer heads loose or stem loose in the butt.
2. Set screw of butt plate loose.
3. Bushing worn in the hammer flange.

Jars--Metallic.

1. Set down with screw driver.
2. Drive wedge above agraffe.
3. Place felt between wire and pressure bar.
4. Place felt between them.

5. Put piece of veneering in pin holes.
6. Use piece of action leather under strings.
7. Remove substance.

8. Raise block.

9. Lower bridge or file brace.

10. Cut off key.
11. Rebush.

12. Tighten.
13. Put paste board under castor.
14. Spread.
15. Place piece of felt under lower coil.

16. Replace with larger pins.
17. Bend or reglue.

18. Use extra tip see No. 7, page, 37
19. Remove.

20. Tighten with cheese cloth.
21. Take off and twist.
22. File end of spoon.

Jars--Wooden or Chucking.

1. Reglue.
2. Tighten.
3. Larger pin.

4. Back stop stem loose in the butt or back stop.
5. Flange screws loose.
6. Set screws of the damper blocks loose.
7. Felt on the jack check worn into the wood or unglued.
8. Felt worn from the back check.
9. Felt worn from the damper lever so that the spoon strikes the wood.
10. Flange pins loose in the extensions.
11. Key rocker screws loose.
12. Key punctures too large for the centre pins.
13. Bushing worn from the key button.
14. Back check wires strike the regulating screw rail.
15. Cheeks of the case loose.
16. Key frame loose.
17. Some hard substance on the key cushion or punchings.
18. Action screws loose.
19. Sounding board buttons loose.
20. Sounding board checked or bars loose on the board.
21. Pedal sticker loose.
22. Pedal guard loose.
23. Panel or silk on the fret work loose.
24. Ivory on the keys loose.
25. Jack flange unglued.
26. Punchings worn from the regulating button.
27. Key leads loose.
28. Back checks strike the top frame or panel as they return to their normal position.

Jars--Sympathetic.

Sympathetic jars are caused by anything foreign that is loose and in sympathy with some pitch of the piano, such as ornaments on the piano, gas fixtures, window panes, etc.

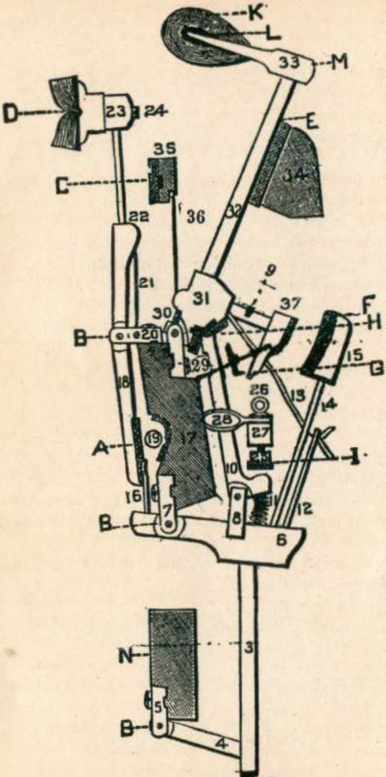
4. Reglue.
5. Tighten.
6. Tighten carefully.
7. Reglue.

8. New piece.
9. Reverse felt.

10. Use larger pin.
11. Tighten and look out for lost motion.
12. Use thread, see page 33, No. 1.
13. Wedge or rebush.
14. Replace rail and tighten screws.

15. Tighten screws.
16. See No. 13, page 35.
17. Remove.

18. Tighten.
19. Tighten screws.
20. If the board is cracked, cork or wedge with toothpick, if the bars are loose reglue and screw.
21. Place small piece of action leather in pedal foot.
22. Tighten screws.
23. Place felt between silk and fret work.
24. See No. 12, page 35.
25. Reglue.
26. Renew punching.
27. See No. 5, page 35.
28. See No. 13, page 39.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UPRIGHT ACTION PARTS.

1. Capstan screw.
2. Key.
3 Extension sticker or abstract.
4 Extension guide.
5. Extension guide flange.
6. Jack rocker.
7. Jack rocker flange.
8. Jack flange.
9. Back stop stem.
10. Jack.
11. Jack spring.
12. Bridle wire.
13. Bridle tape.
14. Back check wire.
15. Back check.
16. Spoons, straight or crooked.
17. Main action rail.
18. Damper lever.
19. Damper rod.
20. Damper flange.
21. Damper spring.
22. Damper wire.
23. Damper block.
24. Damper block screw.
25. Regulating button.
26. Regulating screw.
27. Regulating screw rail
28. Regulating screw rail bracket.
29. Butt flange.
30. Brass butt plate.
31. Hammer butt.
32. Hammer shank.
33. Hammer.
34. Hammer rail.
35. Spring rail.
36. Hammer spring.
37. Back stop.
A Action cloth.
B Bushing cloth.
C Spring rail felt.
D Damper felt.
E Hammer rail cloth.
F Back check felt.
G Block rail.
H Action leather.
I Regulating punching.
K Hammer felt.
L Under felt.
M Hammer head.
N Extension rail.

SQUARE PIANO-FORTE ACTION.

(For defects in keys, see upright action.)

Jack Sticks or will not get under the Hammer Knuckle.

1. When the bushing is too tight.
2. When the thread to which the jack spring is fastened has slipped between the jack and key rocker.
3. When the jack spring is broken.
4. When the key rocker is too high.

5. When the jack spring is too weak.

6. When pressure is brought to bear on top of the keys, such as the name board or key rail.

Jack Squeaks.

When the bushing becomes hard, or the spring rubs against the key rocker.

Hammers Stick.

1. When the set screw on flange is too tight. This ought to be so adjusted that the hammer will rebound several times by raising it and letting it fall of its own weight against the stem cushion.
2. When hammer heads interfere.
3. When the hammers strike against the pin block in the upper part of the piano.

SQUARE PIANO-FORTE ACTION.

Jack Sticks or will not get under the Hammer Knuckle.

1. See No. 2, page 37.
2. Replace thread.
3. Put in new spring or tie broken ends of spring together with thread.

4. Lower just enough to allow the jack to get under the hammer knuckle.
5. Strengthen by cutting off a few coils of the spring, or put in a new one.
6. Test: Lift up on key. If it cannot be raised one-sixteenth of an inch above the level of the key above and below, remedy by putting a piece of card board a thirty-second of an inch thick under the name board on each key block.

Hammers Stick.

1. ——
2. Space the hammers by loosening the flange screws and moving hammers until right, then tighten screws.
3. Give the screw that is placed in the back of the case about one half turn out; if there is no screw glue a piece of card board on the end of cross piece of key frame.

4. When the back check does not catch the hammer high enough. A heavy blow of the key in this case causes the hammer and back check to bind or choke as the hammer returns. If on the contrary the back check is too close, the key cannot be lowered so as to lift the hammer to the strings without increasing the pressure.
5. When a hammer strikes the sounding board bracket.
6. When a hammer butt strikes a sounding board bar.

Hammers Rattle and Squeak.

Hammers rattle and squeak from the same causes as in the upright action except in case of a hammer stem or butt striking against a sagged sound board. Sometimes a key will at first resist the touch of the finger until the pressure has been increased. This is usually caused by the:—

1. Punching wearing off from the regulating button.
2. Wearing of the jack cushion from the hammer butt.
3. Jack needs black-leading.
4. Back check being too close.

Hammers Block.

1. If the punching is worn from the regulating button.
2. If the regulating screw is too high.
3. It is possible for a hammer to block if the jack cushion has become too thin, thus allowing the jack to rest so far under the knuckle that the let-off screw connot release the jack.

4. ——

5. Space hammer.

6. Saw the butt where it comes in contact with the bar.

Hammers Rattle and Squeak.

1. Renew.

2. Renew.

3. ——
4. Regulate as in Swiss grand, see No. 17, page 83.

Hammers Block.

1. Renew.

2. Lower regulating screw until the hammer lets off at one-eighth of an inch from the strings.

Hammers Strike the Wrong Strings.

It is possible, but very unusual for a hammer to strike a semitone above. If several of the hammers strike the wrong strings it is usually a semitone below.

To remedy this,

1. See that the action is in its proper position.
2. See that the stems are not twisted.
3. See that the hammers are properly spaced.
4. See that the upper and lower bridges are sound. If either of these were split the pressure of the strings against the bridge pins would displace them so that the strings would move enough to be struck by the hammer of the next semitone. If the above are all right the fault can be remedied by putting a narrow piece of paper under the lower side of the flange of the hammer that strikes the semitone below. Never try to remedy this fault by spacing the hammers unless they have shifted. To ascertain this notice whether the hammers strike the back check in the old marks that were made while the hammers were striking true. This caution will save cutting the felt when it is not necessary, as it is far more injurious to the piano than one who uses his knife ignorantly might think.
5. If the above remedies fail it is a positive proof that the hammer shank is too short. This can be fixed in three ways.
    1. By putting in a new and longer shank.
    2. By taking off the hammer, and, instead of gluing it back so that the shank passes through the hole in the head, allowing the head to extend about one-sixteenth of an inch beyond the end of the shank.

3. By cutting an oblong hole in the hammer flange this will allow the flange to be set back toward the back check enough to remedy the fault.

Dampers Rattle.

1. If the nuts of the damper cap rail props are loose.
2. If the damper bolt is loose.
3. If the damper lever rubs against the rail prop.
4. If the lever flange is loose.
5. If the damper leads are loose.
6. If the bushing is worn so that the damper lifter wire rubs against the strings. This can be remedied by separating the strings with a wooden wedge.
7. If the punching is moth eaten so that the lower damper lifter button strikes the strings it can be remedied by putting in new punching.

Dampers will not Damp Properly.

1. If the lever flange screw is loose, thus allowing the lever to move to one side.
2. If the damper head is unglued.
3. If the felt has become hard or is moth eaten.
4. If the bushing in the lever of flange is too tight.
5. If the bushing through which the damper lifter wire passes is too tight. This can be remedied by heating a piece of wire the same size as the lifter wire which will burn the bushing a trifle, thus allowing the lifter wire to work freely. In burning out the bushing care must be used or else the bushing will be displaced by clinging to the heated wire. The best way is to insert and remove the heated wire quickly, which will not give time for the bushing to cling to the wire.

6. If the lower lifter button is too low.
7. If the felt is too thick between the arm of the flange rail and plate.
8. If the pedal action is too close, thus holding the dampers away from the strings.
9. If one string of a unison is raised a trifle above the other. This can be caused by the bridge checking between the unison wires thus throwing them out of line.
10. If the punching on the upper button sticks against the lever.

    This can be remedied by black leading the lever where the punching rubs.
11. If the bolt which holds the damper flange rail has worked out.
12. If the pin which supports the other end of the rail has worked out.
13. If the threaded portion of the lifter wire catches on the bushing. This can be remedied by filing the threaded portion of the wire smooth.
14. If the lever flange pinches the lever. Remedy: File the lever enough to free it without removing the pin.

How to take out the Chickering Metallic Upright Action.

1. Take screws out of key strip.
2. Take screws out of key blocks. (If screws are used.)
3. Take screws out of key frame. Sometimes they pass up through the key bed into the front rail, and sometimes down through the front rail into the key bed.
4. Take screws out of the upper end of the action brackets. (If screws are used.)
5. The action and keys will then slide out just as the Square or Grand actions do.

How the Square Action is Fastened in.

FIVE WAYS OF FASTENING IN THE NAME-BOARD.

1. The name board is fastened by being screwed to the key blocks. To take out the name board, the action must be removed.
2. The name board is held in place by a little button, placed on the under side of the case directly over the key block at the bass end of the key board. To remove the name board, turn button around and push in on the lower edge of the board, this will tip it.
3. The name board is held in by a spring placed in the same position as the button of No. 2. To remove the board lift up the spring and push in on lower edge of the board.
4. The name board is furnished with two little knobs, one at each end. To remove board take hold of knobs and push to the right, or left, which will free one end of it.
5. The name board and front of the case are in one piece. To remove the board lift up on it.

Key Slip.

1. The key slip is fastened in by slipping down over screw heads placed in the front rail. To remove the key slip lift it up.
2. The key slip is glued to the front rail and key blocks. In this case the slip cannot be removed but comes out with the action.

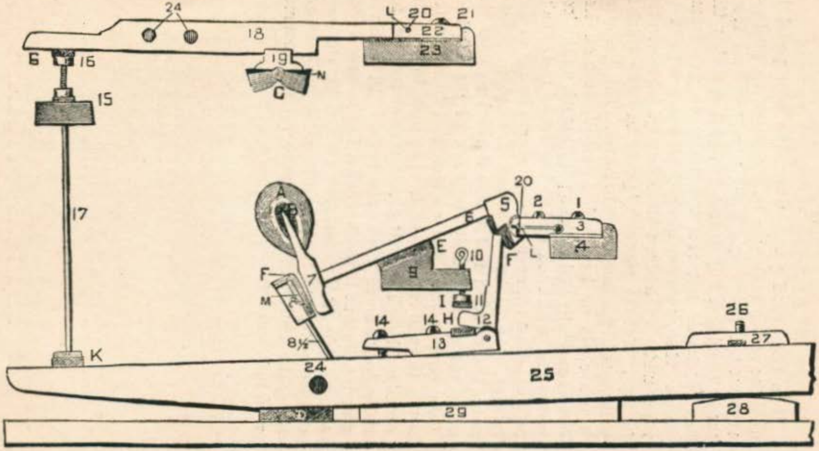
How the Action is Fastened in.

1. By screws passing down through the front rail into the key bed, directly back of the key slip. To get at screws remove key slip.
2. Screws pass down through the front rail into key bed, between the punchings of the white and black keys. To get at screws remove the name board, lift up the E and F keys as the screws are usually placed under those keys.
3. The screws pass down through the front rail into the key bed and are covered with a continuous strip of felt that is used instead of punchings. To get at the screws, lift up the front edge of the felt.
4. One screw in centre of key frame passing down through front rail into the key bed. The other two screws will be found under the key blocks. To get at the srews lift up the key blocks.
5. Screws pass up through the key bed into the front rail, and in some cases there will be two extra screws passing up through the key bed into the center pin rail.

Sometimes these screws are in the form of a lag bolt with an oblong head. It will be necessary to put the oblong tip in the T hammer in order to take out the screws.

If in the grand piano when the soft pedal is used the action is slow in moving back to position examine the following. First wipe the dust from the key bed and key frame. Second see that the key blocks do not rest too firmly on key frame slides. If so, remove blocks and place a piece of paper under each block thick enough to lessen the friction. If these pieces of paper are too thick it will cause key frame slides to rattle. Third, scatter french chalk on key bed. Fourth, remove key blocks carefully and make a pencil mark on the key bed in line with each end of the front rail. Take hold of action frame and see if it can be set in any farther. If not take out the action and plane or sand paper the cushion rail where it rests against the guide blocks placed at the back of the key bed. Take enough from the cushion rail to allow the action to go in one-sixteenth of an inch beyond the pencil marks. This will give sufficient freedom for the action to move from right to left. In the Swiss grand if the tone is weak when a key is struck with a heavy blow, it is sometimes caused by the jack cushion being too thick to allow the jack to get under the knuckle far enough to lift the hammer with sufficient force.

SQUARE PIANO ACTION.



AMERICAN SQUARE ACTION PARTS.

1\. Hammer flange screw.
2\. Hammer bushing adjusting screw.
3\. Hammer flange.
4\. Hammer flange rail.
5\. Hammer butt.
6\. Hammer shank.
7\. Hammer head.
8\. Back check.
8½ Back check wire.
9\. Hammer shank and regulating rail.
10\. Regulating screw.
11\. Regulating button.
12\. Jack.
13\. Key rocker.
14\. Key rocker screws.
15 and 16. Damper lifter buttons.
17\. Damper lifter wire.
18\. Damper lever.
19\. Damper head.
20\. Flange pins.
21\. Damper lever flange screw.
22\. Damper lever flange.
23\. Damper lever flange rail.
24\. Damper lever and key leads
25\. Key.
26\. Centre pin.
27\. Key button bushed.
28\. Centre or balance pin rail.
29\. Key frame.
A Hammer felt.
B Under felt.
C Damper felt.
D Cushion rail.
E Hammer rail felt.
F Action Leather.
G Lifter button felt.
H Jack check.
I Regulating punching.
K Damper lifter wire cushion.
L Bushing cloth.
M Action cloth.

OLD ENGLISH SQUARE.

1. Key.
2. Base.
3. Fly or jack.
4. Fly or jack Spring.
5. Regulating screw.
6. Under hammer.
7. Under hammer rail.
8. Hammer rail.
9. Damper lever.
10. Damper sticker.
11. Damper lifter wire.
12. Damper.

Faults of the Old English.

1. Keys Rattle. Remedy by wedging the punctures.
2. Base unglued. Remedy: Take out key and reglue base. To remove key take out under hammer rail.
3. Under hammer rattles or squeaks. Remedy: Renew the felt or leather on the under hammer. Look out for let off,
4. Hammer rattles or squeaks from same cause as upright. See page 47.
5. Damper rattles. Remedy: If worn renew bushing around lifter wire. If damper felt is hard, soften with felt scraper.

Lost motion is regulated by placing a piece of wrapping paper under the felt beneath the under hammer to put in lost motion.

Back checks are regulated same as Swiss. Page 83, No 17.

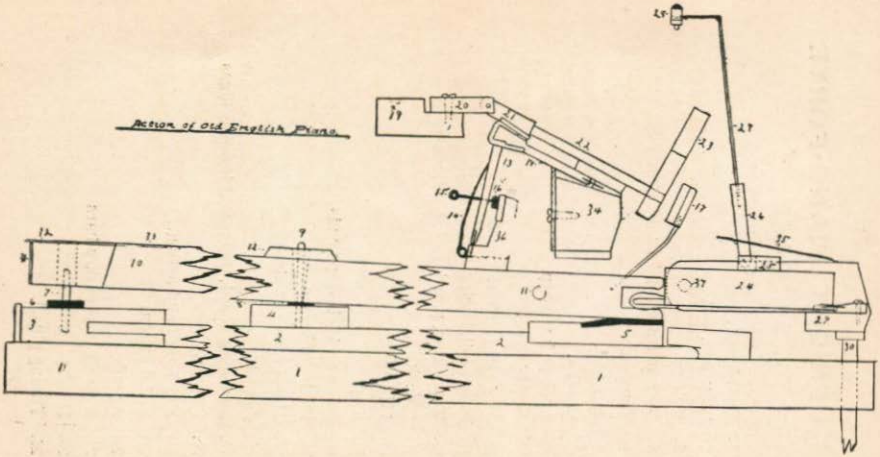
The dip of the old English is two eighths of an inch

Rebounding hammers are remedied by renewing the felt or leather on the under hammer. Look out for let off.

UPRIGHT PIANO-FORTE CASE.

1. Base block.
2. Stretcher.
3. Bottom.
4. Bottom frame and panel.
5. Trusses.
6. Key bed.
7. Cheeks.
8. Lock or key strip.
9. Key blocks.
10. Key rail or name board.
11. Front fall, back fall and shelf.
12. Top frame, panel, fret work, music or swinging desk.
13. Pilasters.
14. Top.
15. Plain and telescope ends.
16. Skeleton frame.
17. Metal frame or plate.
18. Pin block.
19. Sounding board, upper and lower bridges.
20. Strings.
21. Key board and action.
22. Pedal action.
23. Agraffe.
24. Bearing or pressure bars.
25. Hitch pins.
26. Tuning pins.

Action of Old English Piano.



OLD ENGLISH PIANO ACTION PARTS.

1. Key bed.
2. Key frame.
3. Guide or front rail.
4. Centre or balance rail.
5. Cushion rail.
6. Front rail punching.
7. Front rail pin.
8. Balance rail punching.
9. Balance rail pin.
10. Key.
11. Key lead.
12. Key button.
13. Fly.
14. Fly spring.
15. Regulating screw.
16. Regulating screw button.
17. Back check.
18. Under hammer.
19. Hammer flange rail.
20. Hammer flange.
21. Hammer butt.
22. Hammer shank.
23. Hammer head.
24. Damper lever.
25. Sticker flange.
26. Sticker.
27. Damper lifter wire.
28. Damper.
29. Damper pedal action.
30. Pedal sticker.
31. Ivory front.
32. Ivory head.
33. Ivory tail.
34. Under hammer rail.
35. Pedal lever flange rail spring.
36. Base.
37. Damper lever lead.

BROWN GRAND.

1. Jack.
2. Jack spring.
3. Jack catch.
4. Under hammer.
5. Under hammer spring.
6. Under hammer catch.
7. Regulating screw.
8. Hammer butt, shank and head.
9. Back check.
10. Damper.
11. Damper lever.
12. Damper lifter wire.
13. Under hammer rail.
14. Hammer rail.
15. Regulating rail.
16. Stroke regulating screw.

If the hammers rebound on the Brown Grand, renew the leather on the under hammer. If there is a stroke regulating screw, lower it a trifle. This will raise the hammer shank a little above the shank cushion. The let off must always be looked at as the hammers are liable to block after the stroke has been shortened.

The lost motion on the Brown is regulated by the under hammer or jack catch.

Faults in the Brown.

1. Sticking, squeaking and rattling keys are remedied the same as in the upright action.
2. Jack squeaks where it touches the let off screw punching. Remedy: Put powdered graphite on the jack.

3. Jack flange unglued in the key. To take out the key, the hammer and regulating rails must be removed. Before lifting up the key displace the jack and under hammer springs.

4. Jack becomes noisy in returning. Remedy: Soften jack cushion on under hammer with felt pickers.

5. Jack rattles when bushing is worn too large for pin. Remedy: Use larger pin.

6. Jack squeaks when spring wears nap off from felt in spring channel; also in bushing joint. Remedy: Use tallow or black lead in spring channel and touch the end of flange pin with toothpick dipped in oil.

7. Jack clicks when felt wears off from jack catch, or if side of jack catch strikes under hammer catch. Remedy: Renew felt on jack catch. Unscrew under hammer catch and place a piece of thread in the hole before replacing the catch. This will prevent the catch from twisting.

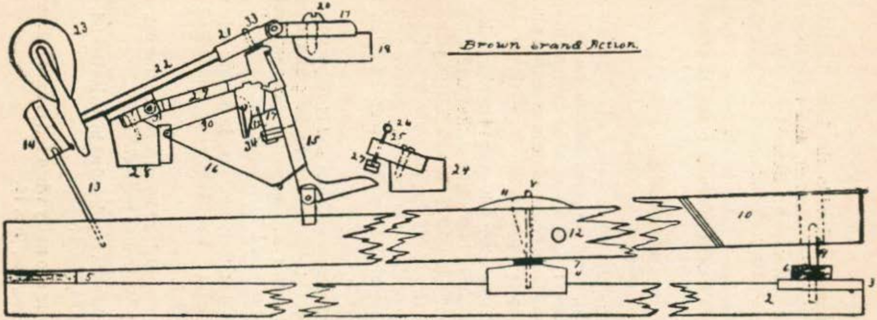
8. Under hammer squeaks and is noisy when the leather is worn where the jack and hammer butt touch it. Remedy: Renew leather. Look out for let off.

9. Under hammer squeaks in spring channel. Remedy: Use tallow or black-lead the channel.

10. Hammers rattle or squeak from same causes as in upright. See page 47.

11. Back check is regulated as in Swiss Grand. See page 83, No. 17.

12. Dampers are noisy when felt is hard. Remedy: See page 83, No. 18.



BROWN GRAND ACTION PARTS.

1. Key bed.
2. Key frame.
3. Front rail.
4. Centre rail.
5. Cushion rail.
6. Front rail punching
7. Balance rail punching.
8. Balance or centre pin.
9. Front rail pin.
10. Key.
11. Key button.
12. Key lead.
13. Back check wire.
14. Back check.
15 Jack.
16. Jack spring.
17. Jack cushion.
18. Hammer flange rail.
19. Hammer flange.
20. Hammer flange screw.
21. Hammer butt.
22. Hammer shank.
23. Hammer head.
24. Regulating screw rail.
25. Regulating screw.
26. Regulating screw eye.
27. Regulating button.
28. Under hammer rail.
29. Under hammer.
30. Under hammer spring.
31. Under hammer flange.
32. Under hammer catch
33. Stroke regulating screw.
34. Jack catch.

SWISS GRAND PIANO-FORTE ACTION.

The Parts are as Follows:

1. Grand Extension—its use having already been described in the upright action.
2. Grand Support.
3. Grand Support Flange, to which is pinned the rear end of the support that is left free to act at the other end.
4. Jack, which is held in position by being pinned into mortise of the front end of the support.
5. Jack Spring which returns the jack to position when in use.
6. Grand Repetition Lever. Its use is to support or balance the hammer, by so doing giving freedom to the jack in returning to position for the next blow, in order to insure rapid repetition of the action.
7. Repetition Spring. Its use is to support the repetition lever.
8. Repetition Hook. Its use is to check the repetition lever.
9. Lost Motion or Repetition Regulating Screw. Its use is to regulate the height at which the repetition lever rests above the jack—one sixty-fourth of an inch—thus giving the jack freedom to get under the knuckle.
10. Repetition Lever Button; to which is glued the repetition lever punching.
11. Base or Spoon, against which rests the punching that is glued to the button, which in its turn is attached to the jack regulating screw. This screw regulates the distance that the jack gets under the knuckle.

12. Escapement or Regulating Screw. Its use is to regulate the distance at which the hammer lets off from the strings, which is one-eighth of an inch. To prevent the jack from coming into noisy contact with this regulating screw there is a felt punching glued to the button that is fastened to the regulating screw.

13. Drop Back Regulating Screw in the hammer flange for repetition lever. Its use is to regulate the distance at which the repetition lever holds the hammer after it has let off. This is from two to three-eighths of an inch, and can only be tested by pressing the key down very slowly, as a blow would send the hammer against the back check.

14. Stroke Regulator, Rocker or Capstan Screw. This is used to remedy a hammer if rebounding on the jack. Raise the capstan screw or rear end of the rocker. This raises the hammer stem a trifle above the stem cushion thus lessening the stroke of the hammer and thereby remedying the fault.

15. Repetition Lever Flange, to which is pinned the repetition lever.

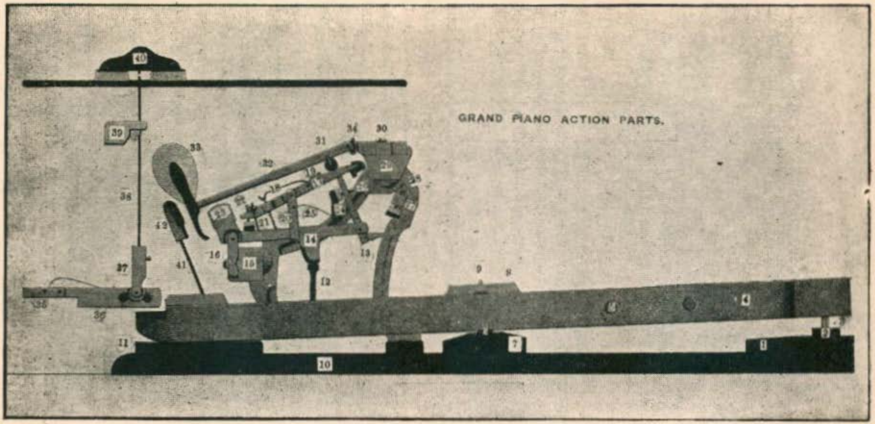
16. The different rails used in the grand action are (*a*) the hammer rail, (*b*) the wippen rail, (*c*) the regulating rail.

Back Check.

17. The back check is regulated so that there is a space of one-sixteenth of an inch between the back check and hammer as they pass each other.

Dampers.

18. Dampers are noisy when felt becomes hard. Remedy: Use felt scraper.



GRAND PIANO ACTION PARTS.

SWISS GRAND ACTION

PARTS.

1. Front rail.
2. Front rail punching
3. Front rail or guide pin.
4. Key.
5. Key lead.
6. Centre or balance rail punching.
7. Centre pin rail.
8. Key button.
9. Centre pin.
10. Key frame.
11. Key cushion.
12. Capstan screw.
13. Jack.
14. Grand support.
15. Grand support flange rail.
16. Grand support flange.
17. Repetition lever.
18. Repetition lever spring.
19. Repetition lever spring regulating screw.
20. Repetition lever flange.
21. Repetition lever catch.
22. Lost motion regulator.
23. Hammer shank cushion.
24. Grand spoon.
25. Jack spring.
26. Jack regulating screw.
27. Regulating screw rail.
28. Regulating screw.
29. Hammer flange rail.
30. Hammer flange.
31. Hammer butt.
32. Hammer shank.
33. Hammer.
34. Drop back regulating screw.
35. Damper lever flange.
36. Damper lever.
37. Damper lifter wire flange.
38. Damper lifter wire.
39. Lifter wire guide rail.
40. Damper.
41. Back check wire.
42. Back check.

LOST MOTION.

By lost motion is meant the movement between the jack and hammer knuckle.

It is regulated by means of a capstan screw or rocker on the end of the key.

In taking up lost motion there must be movement enough left between the jack and hammer knuckle to ensure the getting under of the jack.

This slight motion of about one-thirty-second of an inch gives the jack freedom to return, which it must have under all circumstances if the action is to repeat well.

During the winter months this motion will become more and in the summer less, and in some cases so much so as to crowd the jacks against the knuckle and hold the hammers above the hammer rail, which will prevent their returning and also very often cause blocking of hammers.

It is, therefore, necessary to use a great deal of judgment in regulating lost motion.

Before regulating lost motion in the upright piano see that the hammer rail is resting on its cushions.

Hammers can be hardened by ironing them with a small flat iron that has been heated about as warm as is necessary to iron clothes. Lay a damp cloth over the striking portion of the hammers then go over the hammers with the hot iron. The steam and heat will contract or harden the felt.

How to Locate a Squeaking or Rattling Noise in the Upright Action.

1. Hold the damper away from the strings.
2. Disconnect the bridle and hold the hammer against the strings.
3. Lift the extension from the key.
4. Work key only.

If the fault is in either of the above the squeak or rattle will cease when the part tested is held.

To polish ivory use alcohol and whiting on a piece of white felt. Rub until polished.

To polish celluloid use kerosene and alcohol.

THE CARE OF A PIANO.

In the summer months when the fires are out keep the dampness out of the room the piano is in as much as possible and during the winter months when the fires are lighted the temperature should not go above 72° as the mechanism of a piano is delicate and complicated. There are many screws and small pieces of wood that are affected by dampness and heat. These should be carefully and promptly adjusted before the action becomes noisy and the touch entirely destroyed. As such conditions will wear the action parts in a short time. Dust should be kept from accumulating in the action as it works in among the bushings and felt and grates and grinds very much as emery powder would, wearing these parts of the action in a surprisingly short time. If the dust is wiped out of the piano it will prevent moths from destroying the felt. A competent tuner can remedy the above faults if he is employed three or four times a year, as it requires fully as much attention as this to keep a piano in good condition and prolong its usefulness.

OLD ENGLISH ACTION.

Fly Sticks.

If leather on under-hammer is worn or rough the fly will stick against it. Remedy, smooth leather with file.

If parchment is broken take out the key, (see page 74) and with a small hack saw make saw cut along side of parchment in fly and base one fourth of an inch deep. In these saw cuts glue a new piece of parchment.

Before doing any extensive repairs or regulating on an action see if the key bed has sagged. This is ascertained by use of the straight edge, if the bed has gone down there will be a hollow in the middle of the key board, it would be impossible to regulate the action accurately if such were the case. To remedy this take out the key frame and place pieces of card board between the centre rail and key bed just thick enough to bring the low keys up in line with the high or end keys. In the grand or square these pieces will sometimes have to be glued to the centre rail or key bed.

Rattling caused by a sounding board bulging up and coming in contact with hitch pin that has been driven too far if pin cannot be pulled out a trifle take out the action and push up on the board hard enough to force it against the pin, this will dent the board deep enough where the pin touches to allow it to vibrate without coming in contact with the pin.

Hinges of harp loose. Tighten screws that hinges work on but not enough to cause sticking as that would prevent the soft pedal from returning.

Harp or soft pedal resting on the sound board. Glue piece of action leather or felt on under side of harp between board and harp.

Screws or pins in hinges of cover loose. Tighten screws and bend pins to make them fit tight in hinges.

If hammers rub against the case and sounding board when the action is removed and put back again in the square piano, it can be remedied by lowering the regulating screw or hammer cushion rail enough to allow the hammers to pass under the board without touching. This can be done by cutting down that portion of the brackets on which the rail rests. This will leave the jacks too high or too long to get under the hammer knuckle. If they cannot be lowered enough by letting down the key rocker, the end of the jacks will have to be cut off a trifle. This must be done carefully. If too much were taken off from the jacks it would entirely destroy them.

When the bass strings give out a dull dead tone the winding is filled with dust or the wire has lost its life, or the strings do not rest firmly on the bridge. Wipe the dust from the strings. Set them down with a screw driver. If this fails to restore the tone the only remedy is a new set of strings. Strings will sometimes break if the hammers have shifted and are merely striking one string. If the hammers block. If the soft pedal is used while the piano is played with some force, also if the eye of the tuning pin is too sharp or has not been slightly counter-sunk.

In ordering wound strings send the broken wire to the string winder. This will avoid all errors. In tuning the lowest three or four notes, if the pitch of the string cannot be detected, place the second finger lightly on the middle of the string back of the key bed. The string will now sound its octave which can be compared with the unisons of the octave above the note being tuned. By doing this the pitch of the string can be easily found. New ivories can be discolored to match old ones by the use of lemon juice. In replacing ivories use glue. In putting on celluloid use cement. Cement can be made of one part white shellac dissolved in one part spirits of camphor, three to four parts of 90 per cent. grain alcohol. How to know when upright action is in proper position. See if the feet of action brackets are in the cups, or on the posts, and upper end of brackets firmly fastened to the bolts in pin block.

In some upright pianos the fall board cannot be removed by lifting it up, but will have to be pushed in or out in order to bring the openings on the under side of the board over the screws placed in the cheeks. When these openings are over the screw heads the board can be raised and removed.

In the grand piano the fall board can sometimes be taken out by lifting it up. In other cases it is pinned to the key blocks and cannot be taken out until the screws are removed from the blocks. When taking out the fall board care should be used not to wedge it. Should it get wedged free it by striking it lightly with the hand at the end that is farthest out. A damper lever in the upright piano will sometimes strike against the brace of the plate. This can be remedied by cutting down the lever where it hits. Then glue a thin piece of felt over the part that is cut. The pedal feet of the Steinway Grand can be taken out by removing the screws that hold the plate that the feet are fastened in. In other grands the lyre must be taken off and the feet can be removed by unscrewing the board on the bottom of the lyre. The sostenuto or third pedal is to hold the damper up during the note's full duration. In some pianos the flanges that hold the sustaining rod are furnished with oblong screw holes. If the screws get loose the rod will move back too far and hold the dampers up, thereby causing the piano to cipher. If the rod moves forward it will miss the dampers. Before taking out the square action notice carefully its exact position. Doing this will aid in getting it back to its proper place. In some square pianos when the hammer shanks strike the sounding board it is caused by the hammer felt becoming thin, and the best remedy in this case is a new set of hammers.

The grand piano action is fastened in by screws passing up through the key bed into the key strip and key blocks. In some German makes the key strip is held in by wooden buttons placed on the under side of the key bed. To take out key strip turn the buttons to one side and push down on the strip. If the action is slow in the grand piano see if the key punctures and hammer flange bushings are too tight, if so free them a little but not enough to cause rattling. See sticking hammers and keys, pages 45, 30. If this does not remedy the difficulty take out the keys and remove a key lead from each key. See page 27. In grand pianos with the Swiss action, if iron action brackets are used instead of wood the action parts can be taken off the keys by removing the screws in the bracket feet. If wooden brackets are used and they are screwed and glued to the key frame, the only way to take out the keys, if extensions are used instead of capstan screws, is to disconnect all of the extensions then take out hammer and grand support rails with all action parts attached.

In the square piano if the dip is wrong it can in some pianos be regulated by taking out the screws that hold the centre rail to the key frame, and by placing a piece of thin pasteboard between the centre rail and key frame the dip will be increased and by taking out a piece it will make the dip less. Doing this will not throw the keys out of level. A difference of one and one-sixteenth of an inch key leverage will make a heavy touch, while a difference of three and one-half inches or more will make a light touch.

INDEX.

Action, 7
Action parts, square, 73
Action parts, upright, 61
Action slow in grand, 71 92
Ancestor of piano, 4
Back check, 29 38, 49, 50, 55, 64, 83
Bass strings with dull dead tone 90
Bell tones, 8
Bridge, 9
Bridle, 36, 52, 55
Brown grand, 78
Brown grand action parts, 81
Brown grand faults, 78
Brown grand hammers rebound, 78
Bushing flange, 25
Capping hammers, 22
Celluloid, how to cement, 90
Chickering metallic action 69
Clavichord, 4
Coleman's Aeolian attachment 19
Construction of piano, 3
Control of Hammers, 7
Damper lifter wire, 23
Dampers do not damp, square, 23
Dampers do not damp, upright 38
Dampers rattle, square, 67, 74
Dampers rattle, upright, 40, 91
Dampers squeak, upright, 42
Dampers stick, upright, 40
Dampers will not damp, 67
Dip, 23, 49, 53, 92
Dulcimer, 4
Ear accustomed to false pitch 27
Escapement of jack, 28

Fall board, to take out, grand, ...91
Fall board, to take out, upright, ...91
First piano built in America, ...5
Fly does not return, ...24, 89
Grand action, how fastened, ...92
Hammer, ...4, 6, 7, 21, 28
Hammer shanks strike sound board 92
Hammers block, upright, ...48, 64
Hammers need spacing, upright, ...45
Hammers rattle, upright, ...46, 64
Hammers rebound on jack, ...28, 74
Hammers rebound on jack, upright, ...48
Hammers rebound when action is worn, upright, 50
Hammers rub against case and sound board, ...90
Hammers squeak, upright, ...46, 64
Hammers stick, upright, ...44, 62
Hammers strike wrong strings 66
Hammers too soft, ...87
Important parts of piano, ...3
Invention of piano, ...5
Inventor of piano, ...4, 9
Iron, ...5
Ivories, how to clean, ...26
Ivories, how to discolor, ...90
Ivories, how to glue, ...35
Jack, ...24, 50, 62
Jack cushion, ...24
Jack squeaks, ...62
Jack rocker parts rattle 29 36
Jack rocker parts squeak 38
Jack rocker parts stick 36
Jars metallic, ...29 56
Jars, sympathetic, ...58
Jars, wooden, ...56, 89
Key. 3, 7
Key bed 10
Key lead, ...7, 27, 35
Key leverage, ...92

Key slip, 70
Key strip, to take out grand, 92
Key, to take out Brown grand, 79
Key, to take out Old English, 74
Key, to take out Swiss grand 92
Keys rattle, 32
Keys squeak, 36
Keys stick, 30
Level keys, 23, 25, 53
Lost motion, 74, 82, 86
Material used for stringing 6
Metallic sound 6
Mozart's Grand, 26
Musical instrument, 4
Noise, its own characteristic, 27
Old English action parts 77
Old English faults, 74
Old English square, 24, 74
Ordering wound strings, 16, 90
Pedal feet in grand and square 91
Pedal feet in Steinway grand, 91
Pedal Sostenuto 91
Pedal squeaks 54
Piano action 3
Piano, care of, 88
Piano-forte 3
Piano not well balanced, 19
Pianos not tuned by same method 26
Pin block split, 15, 19
Pitch C, 14, 27
Pitch of bass string, 90
Plate 11
Rattling caused by harp, square 89
Rattling caused by loose hinges, 89
Rattling caused by sounding board, 89
Regulating back check, 24
Regulating damper, upright 42
Regulating, order of, upright 52

Regulating or repairing square 22, 23, 89
Repairing pianos, 25, 89
Scale, 5
Screws broken, 12
Sharps and flats made of ivory, 26
Sounding board, 4, 8
Simple tone, 6
Skeleton frame 9
Square action how fastened, 69, 91
Squeaking or rattling, to locate 87
Standing in tune, 9, 13, 14, 16, 18
Striking point, 6
Stringing, 15, 16, 19
Strings, 6, 7, 8, 12, 13, 16, 27
Strings break, 14, 90
Strings need spacing, 16
Surfacing, 21
Swiss grand, 71 82
Swiss grand action parts, 85
Swiss grand dampers noisy, 83
Swiss grand hammers rebound 29 83
Table of vibrations, 28
Tension, 5, 13, 16, 27
Test blow. 18
Touch, 25, 27
Tone, 4, 5, 21
Tuning, 12
Tuning fork 7
Tuning pin broken 12
Tuning pin, how to set, 18
Tuning pin loose, 15, 18
Tuning pin too close 15
Upright action in position 91
Upright case, 9, 75
Vibrations, 4, 16
Virginal, 3
Voicing, 20
Wood, 5, 11

Theory of Piano Tuning

Containing Notes on Harmony, Acoustics and Temperament

by

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TERMS OF HARMONY USED IN PIANO TUNING

Musical pitch is of two kinds, Abstract and Relative. Abstract pitch is the effect produced by any single musical tone, without reference to any other.

By relative pitch we refer to not less than two musical tones, the second of which is a recognizable distance, higher or lower than the first.

By the key of a piece of music we refer to the abstract pitch of its tonic (first tone).

The names of the degrees of the scale are, primes, seconds, thirds, fourths, fifths, sixths, sevenths and eighths or octaves.

The degrees of the scale obtain their names according to the numerical distance, the second is from the first, and are called primes, seconds, etc.

In beginning the study of piano tuning our work consisted exclusively to that of pitch. We cannot depend upon pitch for perfect tuning, although considerable accuracy might be attained.

In order to tune correctly we combine pitch with beats.

Beats do not indicate pitch; they only indicate impurity.

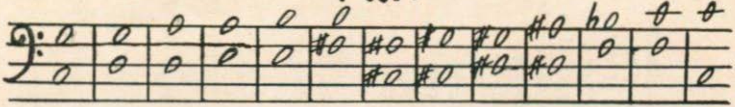
The following is an example on the staff of tuning a circle of perfect fifths and fourths:

As the result of this tuning the octave will be found sharp. See Fig. 1. Page 3.

Example of tuning perfect major and minor thirds. See Fig. 2. Page 3.

Intervals greater than the ninth are usu-

Fig. 1



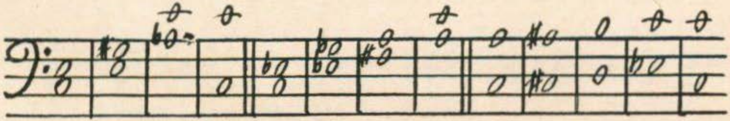


Fig. 2

ally spoken of as within the octave. A note ten degrees from a given tone is usually called a third instead of a tenth. The minor second or semitone is the smallest interval used.

But for the sake of classification some musicians speak of the unison as the smallest interval. The propriety of doing this is questioned by some, as an interval is the difference in pitch of tones, and a unison consists of two or more tones on the same pitch. For example, C sharp and D flat.

Taking the minor second as a unit of measurement, the following is a table of the intervals within the octave:

A minor second occupies two degrees and contains one semitone.

A major second occupies two degrees and contains two semitones.

An augmented second occupies two degrees and contains three semitones.

A major third occupies three degrees and contains four semitones.

A minor third occupies three degrees and contains three semitones.

A diminished third occupies three degrees and contains two semitones.

A perfect fourth occupies four degrees and contains five semitones.

A diminished fourth occupies four degrees and contains four semitones.

An augmented fourth occupies four degrees and contains six semitones.

A perfect fifth occupies five degrees and contains seven semitones.

A diminished fifth occupies five degrees and contains six semitones

An augmented fifth occupies five degrees and contains eight semitones.

A major sixth occupies six degrees and contains nine semitones.

A minor sixth occupies six degrees and contains eight semitones.

An augmented six occupies six degrees and contains ten semitones.

A major seventh occupies seven degrees and contains eleven semitones.

A minor seventh occupies seven degrees and contains ten semitones.

A diminished seventh occupies seven degrees and contains nine semitones.

A perfect eight or octave occupies eight degrees and contains twelve semitones.

A diminished or imperfect eighth occupies eight degrees and contains eleven semitones.

The consonant intervals are primes, thirds, perfect fourths, perfect fifths, major sixths, minor thirds and octaves. The dissonant intervals are seconds, and sevenths. Having tuned a pure minor third above any given note, also from the same note a perfect fifth above. The upper note of the minor third sounded with the upper note of the fifth will form a pure major third. The only consonant intervals remaining for the purpose of tuning are the major sixths. See Fig. 2.

A musical scale is a regular diatonic succession of tones and semitones, terminating in the octave above or below.

The order of tones and semitones in the major-minor and chromatic scales. The major scale is as follows:

Between one and two a tone, two and

three a tone, three and four a semitone, four and five a tone, five and six a tone, six and seven a tone, seven and eight a semitone.

The order of tones and semitones in the melodic minor scale. Between one and two a tone, two and three a semitone, three and four a tone, four and five a tone, five and six a tone, six and seven a tone, seven and eight a semitone.

There are three minor scales, "Harmonic," "Melodic" and "Pure Minor."

The chromatic scale progresses by semitones throughout.

Scales differ one from another, according to the relative position of the tones and semitones.

In modern music but three scales are used,—major, minor and chromatic. A musical interval is the difference in pitch of tones. They are classified as general and specific.

The general names refer to the numerical distance; the second is from the first, and are called primes, seconds, etc.

The specific names refer to the number of semitones. As, for example, the interval from C to E is a third; so also is the interval from C to E flat or C to E sharp, because the numerical distance from C to E, C to E flat, or C to E sharp is three, but the number of semitones varies with each; hence the necessity of a specific name.

A triad is the effect produced by the union of three intervals and contain three letters, two thirds and one fifth.

The order is one, three, five, or C, E, G, for the triad of C.

The effect of a triad depends upon the kind of third and fifth which are produced above the first letter.

This letter is usually known as the root, with the two above it. As, for example, the triad C, E, G, reckoned from the first note C, contains a major third, a minor third and perfect fifth, and is called a major triad.

The triad C, E, flat G contains from the lower note a minor third, a major third and perfect fifth, and is called a minor triad.

Again the triad C, E, G sharp contains a major third C, E, an augmented fifth C, G sharp, and is called an augmented triad.

These different names diminished, minor, major and augmented, refer to the effect of the triads as a whole.

POSITION OF TRIADS

A triad is in its first position when its fifth letter is in the highest voice, C, E, G, in its second position when its root is in its highest voice E, G, C, and in the third position when its third letter is in the highest voice G, C, E.

When the triad is to be used for four or more voices or instruments any of its notes may be doubled, that is, repeated. It is usually best to double the root in preference to the others.

A triad is uninverted when its root is in the lowest voice.

It is the first inversion when the third is in the bass.

The second inversion when the fifth is in the bass.

And in chords of the seventh it is in its third inversion when the seventh is in the bass. Therefore, the term position refers to the highest voice, while inversion refers to the lowest voice.

CHORD OF THE SEVENTH

A chord of the seventh has four letters, the first three of which are the same as those in the triad, the fourth being a third above the last letter of the triad. For example, the chord of the seventh of C has the letters C, E, G, B.

The numerical relation from the first being three, five and seven. This chord is always dissonant in character, and therefore must be used with care. Chords of the seventh are used upon all the tones of the scale. It will be found that the chord of the seventh formed on the fifth and seventh degree of the scale is much milder and more often used than those founded upon the other degrees.

It will therefore be best to become familiar with those two chords in all the keys.

The chord of the seventh has one more position and inversion than the triad, by reason of its additional letter, so that there are four positions and three inversions. An arpeggio consists of three letters, of a triad or chord played one after another, and as this is of especial use in pianoforte tuning, the student should become familiar by practice with this method of using chords by playing in both left and right hands.

(N. B.—It is believed that the above out-line of harmonic principles will be sufficient for the immediate needs of the piano-forte tuner.)

Temperament

Temperament is the most important subject in Piano-Forte tuning.

A simple definition of which is, such a distribution of the imperfections of the octave among the different intervals within the octave that the semitones are made equal.

The system used is the third system which consists of four series of three major thirds each.

First series C to E, E to G sharp, A flat to C.

Then tune down a fifth from the upper note of the second major third of the first series. G sharp—C sharp which becomes the basis of the second series.

Second series D flat to F, F to A, A to C sharp.

Then tune down a fifth from the upper note of second major third of second series which is the basis of third series. A down to D.

Third series, D to F sharp, F sharp to A sharp, B flat to D. Tune down a fifth from upper note of second major third of third series. B flat—E flat which is the basis of fourth series.

Fourth series, E flat to G, G to B, B to D sharp.

The minor thirds carry an imperfection equal to more than three times that found in fourths and fifths, while the major thirds carry an imperfection of more than twice that found in fourths and fifths.

We have now established the following principles: All major thirds, perfect fourths, and major sixths are tempered by expansion from the pure point.

All minor thirds and perfect fifths are tempered by contraction from the pure point.

Fourths and fifths contain one-twelfth of the imperfections within the octave. Minor thirds about one-fourth. Major thirds about one-third. The actual increase of each major third over its predecessor is a small amount, five twelfths of a beat per second.

The basis of the second, third and fourth sets of major thirds is established by tuning down a fifth from the upper note of the second major third of the previous set.

The minor thirds carry an imperfection equal to more than three times that found in fourths and fifths, while the major thirds carry an imperfection of more than twice that found in fourths and fifths.

The proof of an octave: a minor third above the lower note should beat the same as the major sixth below the upper note.

Additional proofs of perfect octaves: fourths and fifths below the upper note, also double octaves and tenths.

The proof of a perfect fifth: a minor third above the lower note should beat the same as a major third below the upper note.

The proof of a perfect fourth: a major third below the lower note should beat the same as a major sixth below the upper note.

The proof of a tempered fourth: the

major sixth below the upper note should beat one and one-half beats faster than the major third below the lower note.

The proof of a tempered fifth: the minor third above the lower note should beat a trifle faster than the major third below the upper note.

The temperament is set in the small octave. The octaves above are one lined, two lined, three lined, four lined, and five lined C.

Those below are great, contra, and sub-octave.

Write proof of temperament on the staff. Names and characters of temperament.

X expansion.
△ contraction.
□ faster.
○ equal.

All proofs are written in quarter notes.

THE CONSTRUCTION, REPAIRING AND REGULATING OF PIANOFORTE ACTIONS

The Key-Frame

The key-frame consists of front rail, centre rail, cushion rail, guide and centre rail pins.

These rails are strongly united by cross pieces to prevent their springing or warping, as a slight movement of them would result in the sticking of the keys.

The Keyboard

The keys of modern pianos are usually made of white pine, having the upper surface and front of the long keys covered with ivory or celluloid. That part of the short keys which rises above the level of the naturals is made either of ebony or some other wood stained black. Each key is punctured towards its centre. There is also a second hole bored in the lower side of the front of the key to admit the pin which guides the key under pressure of the finger. On the top of the key, near the centre, is fastened the key-button and at the tail of the key is placed the key-lead. Also rocker or capstan screw. In some pianos the keys are loaded heaviest at the front, while in others they are heaviest at the back, in which case they remain on the cushion when the action is taken from the keys.

The keys are loaded with reference to the weight of the different parts of the action, such as the extensions, jack parts, weight of hammers and strength of hammer and damper springs.

The dip of a key is the distance it travels under pressure of the finger. In modern pianos it averages three-eights of an inch depth and is effected as follows:

1st.—By the length of hammer stroke.

2nd.—By the length of hammer shank.

3rd.—By the point of contact of jack and hammer butt.

4th.—By the position of centre pin between action and guide pin, which is at such distance from the guide pin that three-eights of an inch dip will carry the hammer to the strings, having the greater distance between guide and centre pins as nine to six in order to make the touch of the action light. In regulating dip, it must be deep enough to free the jack after the hammer is let off. This last motion of the key, after the jack escapes, is called after dip, and need not be more than one-sixteenth of an inch. To regulate dip accurately, adjust the first and last key putting in the required number of punchings, always placing paper punchings underneath the felt, after which the remaining keys are brought up to the level with the highest and lowest keys.

To guide the key in its movements there is an oblong pin fastened at one end in the front rail. The other end enters the puncture in the key. This guide pin being of oblong shape, in case of too much side movement in the key, is turned to one side, which will remedy the fault.

There is also another pin fastened at one end in the centre pin rail. In this case the puncture goes through the key and is considerably larger than the pin used to steady or pivot the key. The reason why the puncture in the centre of the key is larger than the pin used is that if it were of the same size as the pin the key being from one to one and one-half inches in heighth, would not allow any movement. In order to overcome any looseness that would naturally result from the largeness of this puncture, there is a small piece of white wood from two to three inches long and about one-eighth of an inch thick set into the bottom of the key with the puncture just large enough for the pin to pass through. On the top of the key there is a button with a puncture of oblong shape, bushed on either side in order to prevent the key from having a side movement, also to make it work quietly.

In the end of the key is placed the key-lead. Its use is to adjust the weight of the action. On the top of the key at the same end is placed the lost-motion regulator, which consists of a rocker, brass or wooden capstan screw, and sometimes, in upright pianos, a flat headed screw that is covered with a piece of felt, fastened at one end and free at the other, to allow raising or lowering the screw, as may be required. These screws are used to take up lost motion between the jack and the hammer knuckle.

Underneath the keys are placed the front and balance rail punchings to prevent their coming into noisy contact with the rails. They also serve the purpose of leveling and regulating the dip of keys. The upright action frame consists of the following:

1st.—Extension Rail.
2nd.—Main Rail.
3rd.—Hammer Rail.
4th.—Spring Rail.
5th.—Block Rail.
6th.—Regulating Rail.

These rails are held firmly in position by action brackets that are fastened at the upper end with action bolts set into the pin-block, while the lower end rests on posts or in cups fastened into the key bed.

The Upright Action

The action of the upright piano is composed of the following parts: Extension and extension guide flange, to which is pinned one end of the extension guide. The other end is joined to the extension, which extends the action to the exact height that the scale of the piano requires and conveys the motion from the key to the whippen, which continues the same through the jack to the hammer butt and that in its turn carries the hammer within one-eighth of an inch of the strings and is then let off through the escapement of the jack which comes in contact with the let off, or regulating screw. This regulating screw, which consists of a threaded wire passing through the regulating screw rail, has a button on one end and a screw eye at the other. This screw is so adjusted that the jack comes in contact with the button when the hammer is within one-eighth of an inch of the strings, which is called the let-off, or escapement. The object of releasing the hammer when within one-eighth of an inch from the strings is to prevent its blocking and avoid all danger of breaking or straining the action and strings.

The Different Parts of the Whippen and Their Uses

On the under side towards the front end of the whippen is pinned the extension, its use being described above. On the upper surface of the whippen and nearly in line with the extension (the extension being a trifle in advance) is placed the jack flange by being glued in the mortise of the whippen, to which is pinned the jack. The jack is a small piece of wood about three inches long, somewhat resembling a hook, which continues the motion from the key through the extension to the whippen, through the jack to the hammer knuckle (the jack having a double movement when in use) and is returned to position by means of a small spiral spring called the jack spring, which is glued in a small hole countersunk in the whippen.

The jack is one of the most important parts of the action, as upon it depends the repetition of the keys as well as the carrying of the hammers to the strings and letting off of the same. On the extreme front end of the whippen are fastened the bridle and back-check wires. The bridle wire is a wire threaded at one end with an eye at the other end in which is fastened the bridle.

The back-check wire is a wire threaded at both ends. On the upper end is screwed the back-check, which is made of wood and covered with felt. The use of this back-check is to check the hammer in its rebound from the strings and it is regulated by bending the wire in order to catch the hammer from five-eighths to one inch from the strings. The higher the back-check catches the hammer without causing it to block or crowding it against the strings the better will be the repetition of the action.

A great deal depends upon the accurate adjustment of the back-check which aids the jack in returning to position for the next blow as well as to prevent the hammer from rebounding.

On the back end of the whippen is pinned the whippen flange which is firmly fastened to the main rail with a flange screw, as this flange must hold the whippen with all its different parts in position.

The whippen is so arranged that when the key is lowered the extension rises carrying the front end of the whippen with it, while the back end of the whippen has a downward movement in the extreme end of which the spoon is fastened.

This movement of the whippen gives the spoon a backward motion on which nearly rests the damper lever, pinned at the centre with a flange pin. There is a threaded wire called the damper wire fastened in the upper end of the damper lever on which the damper block is adjusted (that is, held in position by a set screw). This backward movement of the lower end of the damper lever moves the upper end forward, lifting the damper from the strings and holding it in that position as long as the key is held down, thus allowing the strings to vibrate. The damper begins to lift when the hammer has travelled half the distance to the strings. The pressure required to damp the strings is obtained by means of a spring a few inches long, called the damper spring, fastened at one end in the damper flange, the other end resting against the upper end of the damper lever. The felt used in damping is very soft and spongy in order to damp the vibrating strings noiselessly.

Hammer flanges are of two kinds, wooden and metallic. They are fastened to the main rail with flange screws. The hammer butt is pinned to the flange with a flange pin that either passes through the butt or is held in place by the butt plate, through which a set screw passes to prevent the flange pin from working loose. The hammer butt now being in position, we will consider its different parts.

In the front of the butt there is a hole drilled in which is glued one end of the bridle and backstop-stem. The other end of the bridle is fastened in the bridle wire eye and its use is to help draw back the hammer. It is so adjusted that when the hammer rail is raised one-fourth of an inch from the cushion it draws the whippen and extension with it. On the other end of the backstop stem is glued the backstop, which is covered with action leather on the side coming in contact with the back-check, which is regulated as stated on page 16.

On top of the hammer butt is bored a second hole, in which one end of the hammer shank is glued, which is from five to six inches in length, and is measured from flange pin to the upper surface of the hammer head, which is glued on the other end of the hammer shank.

The longer the shank the quicker and more powerful the blow of the hammer. The stroke of the hammer is from one and three-fourths (1¾) of an inch to two inches.

When the hammer is pressed against the strings the shank should lean a little toward the hammer rail, otherwise the hammer will have a tendency to rest against the strings, which would prevent its freedom of action. To aid the hammer in its return there is a hammer spring fastened at one end in the hammer spring rail with the other end resting on the hammer butt to insure promptness in action when rapid repetition passages are being performed.

Surfacing of Hammers

If the hammers are cut deep enough to cause them to have or give a fuzzy tone they should be surfaced very evenly in order to maintain their original shape.

Capping

The material used for capping hammerheads is the best quality of buskskin and costs from $8.00 to $10.00 per skin. In cutting caps for hammers always cut the leather the way it stretches most. Cut them a little wider than the heads.

Price of Hammer Heads

The price of hammer heads is as follows: for Grand, $6.00 to $13.00; for Upright, $5.00 to $8.00; for Square, $4.00 to $6.00.

New heads are always surfaced or sandpapered after being hung in order that they will strike all three of the strings at the same instant.

Voicing

By voicing is meant the tempering or equalizing the tone.

If the tone of the piano is harsh or metallic it will require a deep pricking, but never prick a hammer so as to form a cushion on the surface of the head, as it would cut through very quickly and cause a dull tone.

Soft heads and too heavy stringing give a dull tone. They can be hardened by ironing them with a hot iron and damp cloth.

In selecting a piano the first good quality is evenness of tone or a good scale. A piano must be evenly balanced to have an even tone. A soft, muffled tone is good proof that the scale is not even or that the bell tones would be prominent if the heads were not voiced very softly.

There are two kinds of scales, flat and overstrung. There are also the A and C scales.

The A is seven and one-third octaves, while the C is only seven.

There are two kinds of plates, full and partial. The full covers the pin-block, while the partial only comes up to the under edge of the block.

John Broadwood in 1870 moved the pin-block of the square piano from the front to the back of the case. He also extended the keyboard and introduced the damper and soft pedals.

In 1807 Southwell came out with the first practical upright piano. He followed out the idea of an upright 14 years or more. Samuel Howe is supposed to have invented the fixed string-plate in 1821.

Harmonics, Beats, Mathematical Formula, Etc.

The pitch of a vibrating string depends upon three conditions, viz.: Length, weight and tension. Increase the weight or decrease the tension and the pitch is lowered, or vice versa the pitch will be raised. All of the above conditions are made use of in the construction of the pianoforte scale.

The tone produced by the vibration of a string is not that of a single pitch only, as the uneducated ear would lead one to suppose, but is a combined effect of many tones.

The most noticeable of all is, however, the lowest in pitch and is named the fundamental note. All above which are called harmonics or over tones.

To enable a string to vibrate it must be stretched between two rigid points or bridges which constitute the real end of the string.

Taking hold of the centre of the string and plucking it to one side it immediately springs back to its position of rest, passes it, returns and thus vibrates, always making a double movement for one vibration. From point of rest out to the right and back to the point of rest, then to the left and back to the point of rest like a pendulum.

The vibration of the string alone is not sufficient to produce a sound, hence it is necessary to have a proper sound-board for stringed instruments, as it is not the strings that throw the air into sonorous vibrations, but the large surface of the sound-board over which the strings are arranged and the air inclosed by this surface, so that the volume of tone almost wholly depends upon the size and quality of the sound-board.

The wood of the sound-board ought to be spruce and of the most perfect elasticity.

If in one lined C we had two beats, two lined C with the same error would have four beats. The character of roughness alters with the number of beats.

Slow beats give a coarse kind of roughness and quick tones a finer, but more cutting roughness, so that we are able with high tones to produce more rapid audible beats than with low tones.

High tones in a chord are much more sensitive to an error in tuning than low ones. The beats of a whole tone in the lower part of the piano are very distinct and powerful which are scarcely audible at the upper limit.

The major and minor thirds in the middle of the scale scarcely show any roughness, but are decidedly rough in the lower octave.

A musical tone or sound is uniform, which remains unaltered as long as it exists.

Hence we anticipate a regular motion of the air which is excited by an equally regular motion of the vibrating string, whose impulses are conducted to the ear by the air.

The movement of the air from a vibrating string spreads out in all directions, just as the waves on a sheet of calm water when a stone is thrown into it.

Musical tones are distinguished first by their force; second by their pitch; third by their quality.

We easily recognize that the force of a vibrating string is greatest when first struck and with a test blow the vibrations are large enough to be seen with the eye, and the tone is loudest, when immediately they become smaller and the tone weaker.

Hence loudness must depend upon the size of vibrations.

Experience teaches that musical tones of the same pitch can be produced upon most kinds of instruments in a great variety of ways, but for the same pitch the air thus excited must be periodic to excite in us a musical tone. If the length of the periodic time of two musical tones is the same they have the same pitch, hence pitch depends upon the number of vibrations completed in a given time. We always use a second as a unit of time.

The higher or lower the pitch the greater or shorter the vibrations.

By quality of a tone we mean the effect which distinguishes a piano from a violin, flute from a clarinet, etc.

When the attention of the ear has been properly directed to recognize harmonics or partial tones it will be quite an easy matter to detect most of them.

The best way to hear them is to strike very lightly the desired tone, and the prime firmly, bearing in mind the former, and by strict attention we can hear the same pitch blending with the fundamental. The series of these upper partial tones is as follows: The first harmonic or second partial tone is the octave of the prime and makes double the number of vibrations in the same time. Great and small C. The third partial tone is the fifth of this octave. Small C and G, making three times as many vibrations in the same time as the prime.

The fourth partial tone is the octave above the fifth or one lined C, making four times as many vibrations in the same time as the prime.

The fifth partial tone is the major third above the octave one lined C and E, with five times as many vibrations in the same time as the prime.

The sixth partial tone is the fifth of the second higher octave or minor third above the major third one lined E and G.

With six times as many vibrations in the same time as the prime. The seventh partial tone is the minor third again above the minor third one lined G and B flat, making seven times the number of vibrations in the same time as the prime.

The eighth partial tone is the major second above the minor third one lined B flat and two lined C with eight times as many vibrations in the same time as the prime.

The ninth partial tone is the major second again above major second two lined C and D, making nine times as many vibrations in the same time as the prime.

And thus they go continually growing fainter. For complete series of harmonics see staff, Fig. 3, page 25.

Diagram of first nine harmonics taken one octave above complete series. See Fig. 4, page 27.

These different pitches are the result of the subdivision of the string into segments

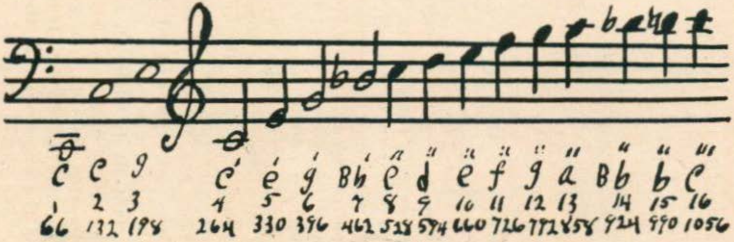

C c g c' e' g' Bb' c'' d'' e'' f'' g'' a'' Bb'' b'' c'''
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
66 132 198 264 330 396 462 528 594 660 726 792 858 924 990 1056

Fig. 3

appropriate for the production of each and all of which are in vibration at the same time.

It is plain that if two strings of the same length, weight and tension are sounded at the same instant the prime and Harmonics of each will vibrate exactly alike.

The result of this simultaneous relation of these two tones which are named unisons produces the simple effect of augmenting the volume of each. If one of the strings vibrates faster or slower than the other it will produce what is known as beats.

The explanation of these beats or pulsations is as follows:

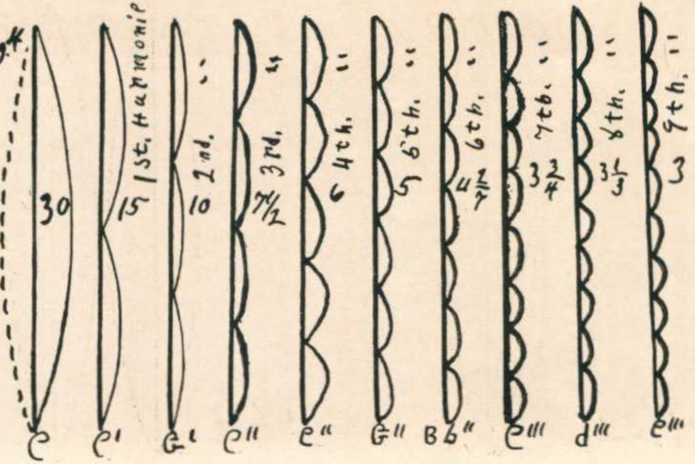
The moment that two unison strings or vibrating bodies are set in motion they assist each other and the force of the tone is increased or equal to the power of both; but if each be vibrating at a different rate the more rapid of the two will immediately gain upon the other and its effect is shown by the diminishing of the tone.

The following diagram will show how the vibrations of the strings are opposed to each other, bearing in mind the movement of a complete vibration as given above. See Fig. 5, page 28.

If the strings are vibrating at the rate of 100 and 101 per second, both starting at the same instant, it is plain that the 101 will gain in one-half of a second just one-half of a vibration, and in one second it will gain one vibration, which is equal to one beat, and the appearance of the strings will be thus. See Fig. 5, page 28.

The beatings of the unisons are caused

Fig. 4.


30
C
15 1st. Harmonic
C'
10 2nd. "
G'
7 1/2 3rd. "
C''
6 4th. "
e''
5 5th. "
G''
4 2/7 6th. "
Bb''
3 3/4 7th. "
C'''
3 1/3 8th. "
d'''
3 9th. "
e'''

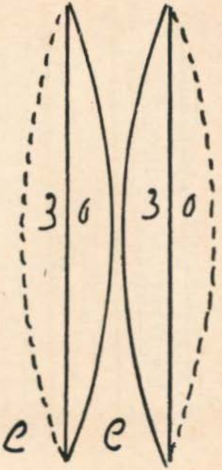


Fig. 5

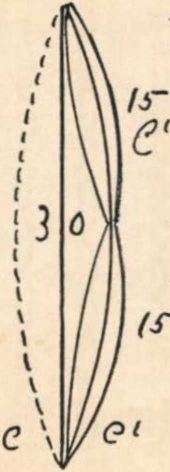


Fig. 6

by the interference of the fundamental, that is by the string that is a trifle sharp or flat of the other.

While those of the octave of this fundamental are caused by the first overtone of the lower or fundamental with the fundamental of the upper. As one-half of the lower string's length is equal to the fundamental of the upper half of the string thus. See Fig. 6, page 28.

If the octave is pure the strings are vibrating at the same rate.

If not pure the number of beats will be in proportion to the error in tuning or difference in the number of vibrations per second. Beats in the fifth are caused by the interference of the second series of harmonics of the fundamental with the first series of the fifth.

By a careful examination of the diagram of harmonics this will be plain. We will also see that there is no length of string caused by a harmonic that produces the true fifth but that of the fifth above the octave, and as it is necessary that we use the true fifth in tuning, we must double the length of string, which gives the harmonic fifth above the octave and will thus become twice its length or twenty inches for the true fifth as follows: See Fig 7, page 30.

It will be seen by the above diagram that the first harmonic of the fifth, viz.: its octave G is a perfect unison with the second harmonic of the fundamental C. If the interval be pure, then the second harmonic of the fundamental with the first harmonic

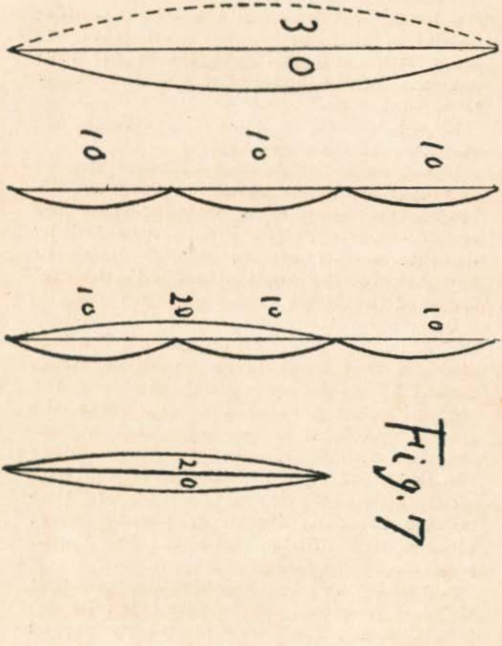


Fig. 7

of its fifth will coincide. If not pure the number of beats will be in proportion to the error in tuning or difference in the number of vibrations.

The fourth harmonic produces the effect of a major third, whose pitch is two and one-third octaves above the fundamental.

The length of string necessary is one-fifth that of the fundamental. See Fig. 8, page 32.

In order to use the true major third in tuning we must increase the length of string four times that of the harmonic, or twenty-four inches as above shown.

By careful study of the diagrams it will be seen that the fourth harmonic of the fundamental C is equal to the first harmonic of the third, that is the length of string necessary to produce a true third E as above stated.

If the interval be pure then the fourth harmonic of the fundamental with the first harmonic of its third will coincide.

If not pure the number of beats will be in proportion to the error in tuning or difference in the number of vibrations.

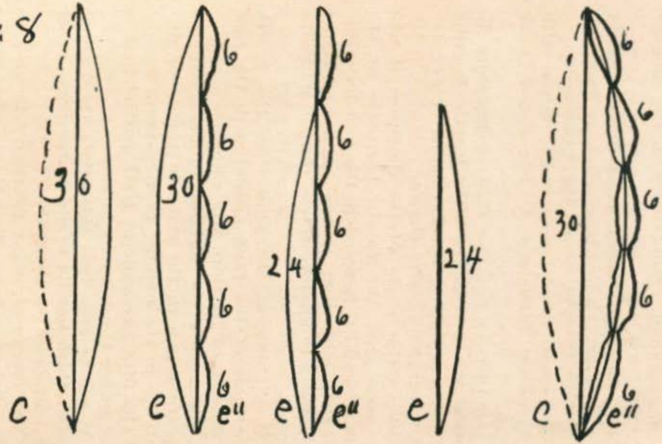
The fifth harmonic or sixth partial tone is the minor third.

It will be seen that this minor third above major third has its origin in the same order of harmonics as the fifth.

The length of string necessary to produce the pitch of a true minor third is five-sixths or twenty-five inches.

If the diagram of harmonics be thoroughly understood it will be plain that the fifth harmonic of the fundamental C is G, whose

Fig. 8



pitch is two octaves and a fifth above the fundamental.

It is also plain that the fourth harmonic of this minor third is G in unison with the fifth harmonic of the fundamental.

The length of string necessary to produce the minor third above major is five inches, as in the following diagram: See Fig. 9, page 34.

If the unison be pure the fifth harmonic of the fundamental and the fourth of the minor third will coincide.

If not pure the number of beats will be in proportion to the error in tuning or difference in the number of vibrations.

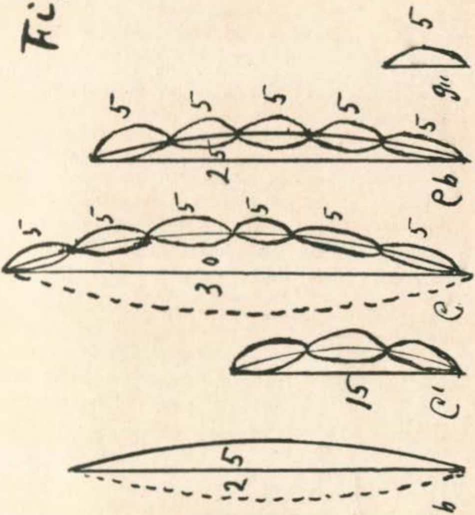
We have now demonstrated that the beats of the minor third are produced by the interference of the fifth harmonic of the fundamental with the fourth of the minor third.

The fundamentals of which are C and E flat.

It is plain by the above diagram that the fifth harmonic of the fundamental small C is exactly the same as the second harmonic of its octave one lined C. As small C and one lined C are pure octaves, the fifth harmonic of small C and the second harmonic of one lined C will coincide, which gives a positive proof of the octave a minor third and major sixth, showing that the harmonics of small and one lined C are vibrating at exactly the same rate.

The reason why we prove perfect consonant intervals is that as soon as the harmonics of the fundamentals of each are vibrating at almost the same rate, the

Fig. 9



stronger draws the weaker, which covers its beatings and causes it to blend before it is in exact pitch.

And by the use of a third or sixth whose beats are not less than five per second, we can immediately determine which is the false one. Also whether sharp or flat, as it is impossible for an interval to draw whose beats are five or more per second.

We are now prepared to understand why the fourth and fifth system added to the error of the drawing of the octave is not a safe or reliable one compared with the equal temperament which is the result of a correct tempering of the major and minor thirds, fourths, fifths and sixths.

The following is a schedule of notes, ratios and pitch numbers:

C'	1:1	264
C' Sharp	9:9½	278 2-3
D'	8:9	297
D' Sharp	5:6	316 4-5
E'	4:5	330
F'	3:4	352
F' Sharp	5:7	369 3-5
G'	2.3	396
G' Sharp	5:8	422 2-5
A'	3:5	440
A' Sharp	5:9	475 1-5
B'	8:15	495
C''	1.2	528

The above pitch is that used by the Society of Arts. The ratio is not that used for equal semitones or temperament as given below.

The following are eight of the principal pitches on two lined C:

Italian Military 511,8

International or French 517, 3 on C or 435 on A.

Scheiblers Stuttgard 523,2

Society of Arts 528

English Band 537,5

Schnitger 581,8

N. E. Conservatory of Music 522

Boston Symphony Orchestra 440 on A

Concert 550

Of the above pitches the International or French is the standard, and the ratio for all tuning of equal temperament and semitones is 1,0594631.

Copley 2569-M